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DNA sequence analysis, morphology and pathogenicity of *Fusarium oxysporum* f. sp. *lentis* isolates inciting lentil wilt in Pakistan

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Abstract

Fusarium wilt of lentil (Lens culinaris Medikus) incited by F. oxysporum f. sp. lentis causes huge lentil yield losses worldwide. Understanding morpho-molecular and pathogenic variation of F. oxysporum isolates is of utmost importance, which has not been previously studied in Pakistan. In this study, extensive two year (2011-12 and 2012-13) wilt surveys of seven districts viz. Chakwal, Jhelum, Gujrat, Sialkot, Layyah, Bhakkar and Khushab of Punjab, Pakistan were conducted, which revealed 100% mean disease prevalence and 25.7% mean incidence. Morphology assessment of recovered 105 isolates showed unique identification characters and variability in morphological measurements that differentiates F. oxysporum from other fusaria. Furthermore, sequencing of TEF-1a gene supported the morphological study and confirmed the associated fungi at species level. Phylogenetic analysis grouped all the selected type 31 isolates, obtained from different districts, under a single lineage within F. oxysporum species complex. Characterized isolates screened for pathogenicity revealed considerable pathogenic variability on two lentil genotypes (NARC-08-1 and Masoor-93). The inoculation of lentils confirmed the pathogenicity of 30 (96.77%) isolates on NARC-08-1 with 0 to 100% disease severity index and incidence with 19.33 to 100% yield reduction. On Masoor-93, 22 (70.97%) isolates were pathogenic with 0 to 66.66% severity index, 0 to 100% incidence and 6.47 to 53.68% yield reduction. Eight (25.81%) isolates viz. FWC15, FWJ35, FWG1, FWL6, FWL9, FWL12, FWB10 and FWK2 proved the most pathogenic resulting in highly virulent disease reaction (94.07% mean severity index and 100% mean incidence and yield reduction) and complete death of the NARC-08-1 seedlings.

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Introduction

Lentil (Lens culinaris Medikus) or masoor is a high value cool season pulse crop and serves as a second major source of dietary proteins (25%) after soybeans in human and animal diet (Rahman et al., 2010). In Pakistan, lentil is the second highly grown winter season legume crop next to chickpea in terms of quality and quantity (Ayub et al., 2001). It is grown on an area of 30.8 thousand hectare annually, out of this, 24 thousand hectare (77.41%) is planted in the Punjab province comprising of Sialkot, Narowal, Gujrat, Rawalpindi, Jhelum, Chakwal and Thal districts where two-third of the area is sown under rain-fed conditions. In Pakistan, about 9.7 thousand tonnes production was recorded during 2012-13, which is much lower than main lentil producing countries, such as, Canada (1.5 million metric tonnes) (Saleem, 2013). The reason to lower productivity includes susceptibility of lentil crop to several biotic and abiotic stresses. Biotic stresses include number of soil- or seed-borne and foliar diseases. Among the soil- or seed-borne borne fungal diseases, the most significant and serious soil-borne threat is the occurrence of vascular wilt disease. It is the most significant disease of lentil worldwide and one of the devastating diseases of lentil in Asia (Erskine et al., 2009). The disease can cause 5-10% losses and may result in total crop loss under conducive conditions (Chaudhary and Amarjit, 2002). In Pakistan, susceptible lentil genotypes have shown 100% yield losses under favorable conditions (Chaudhry et al., 2008). The disease is incited by several species of Fusarium but the most devastating fungus is F. oxysporum Schlecht. emend. Snyder & Hansen f. sp. lentis Vasudeva and Srinivasan (Khare, 1981). Though, isolates of this fungus exhibit significant variability in morphology as well as aggressiveness.

Characterization of associated *Fusarium* pathogens and knowledge of existing variability is very much important and prerequisite for effective management of the disease and therefore, needed to be investigated. Identifications and characterization of *Fusarium* species by morphological characters are highly variable. However, at present various DNA- based molecular techniques are used for identification and determination of phylogeny relationships and study of genetic variability in pathogenic populations of Fusarium species (Belabid et al., 2004). Sequence analysis of certain informative regions of DNA is now becoming interesting. In Fusarium systematics, several molecular methods based on phylogenetic species concept have been introduced and are now being employed for practical molecular taxonomy of this genus (Geiser et al., 2004). The most commonly used sequences based on DNA sequence analysis for distinguishing among the species of Fusarium are portions of the genomic sequences encoding the translocation elongation factor 1-a (TEF) (Wulff et al., 2010). The TEF-1a shows high levels of sequence polymorphism and have been used to design species-specific markers as well as probes for the identification, detection and quantification of pathogenic populations of Fusarium (Bogale et al., 2007; Nicolaisen et al., 2009; Arif et al., 2012). These tend to evolve at a rate higher as compared to other markers that are used commonly in fungi at the species and population level such as the ribosomal internal transcribed spacer (ITS) regions of the nuclear ribosomal RNA gene repeat (O'Donnell *et al.*, 2000).

In order to support the lentil breeding program and enhancing the crop productivity through the development of resistant varieties against devastating wilt disease, assessment of morpho-molecular diversity and pathogenic variability present in *F. oxysporum* isolates is very much essential. Therefore, the study was planned to determine the wilt incidence and prevalence in major lentil producing districts of Punjab, Pakistan and assess the morphology, genetic diversity and pathogenic variability among the currently prevalent isolates of *F. oxysporum* causing lentil wilt in Pakistan.

Materials and methods

Disease assessment and collection of wilted lentil plant samples

Wilt disease surveys during 2011-12 and 2012-13 at two plant growth stages (seedling and reproductive or

adult plant stage) were conducted in seven major lentil growing districts of Punjab, Pakistan viz. Chakwal (32°56'N; 72°53'E), Jhelum (31°20'N; 72°10'E), Gujrat (32°40'N; 74°02'E), Sialkot (32°30'N; 74°31'E), Layyah (23°54'S; 21°55'E), Bhakkar (31°40'N; 71°05'E) and Khushab (32°20'N; 72°20'E). For disease assessment and sampling, 10 spots were randomly selected from each field. The number of total plants and wilted or infected plants in 1 m² were counted. These observations were used to calculate the average wilt incidence in each field.

Disease prevalence and incidence were used to assess wilt distribution in surveyed areas and calculated by using the following formulas:

Disease Prevalence (%) = <u>Number of infected fields</u> x 100
Total number of fields
Disease Incidence (%) = <u>Number of infected plants</u> x 100
Total number of plants

Wilted samples (25-30 per field) were collected by careful observations of typical wilt disease symptoms (Bowers and Locke, 2000) excluding other lentil rootrot diseased plants. Whole uprooted wilted plant samples were collected and stored in a refrigerator at 5-6°C at Fungal Plant Pathology laboratory of the Department of Plant Pathology, PMAS-Arid Agriculture University Rawalpindi for later isolations and confirmation of associated fungus.

Isolation and purification of isolates

The isolation of the associated *Fusarium* pathogens was done using small surface sterilized infected root pieces of the collected wilted lentil plants on potato dextrose agar (PDA) medium (Bayaa *et al.*, 1994). Each PDA plate was plated using five root pieces and incubated at $25\pm2^{\circ}$ C for 3-4 days. The recovered *Fusarium* pathogens were purified on PDA and malt extract agar (MEA) medium using single spore technique (Choi *et al.*, 1999) and later preserved employing silica gel method (Leslie and Summerell, 2006).

Morphological characterization The recovered 105 isolates (Table 1) of *Fusarium* were studied morphologically using the identification key of Nelson et al. (1983) and Leslie and Summerell (2006). Each isolate was characterized based on morphological characters including colony color, growth habit, pigmentation, days to fill 9 cm dish, concentric rings, size of micro-conidia, shape of micro-conidia, size of macro-conidia, shape of macroconidia, phialide, shape of apical and basal cells of macro-conidia, septation in macro-conidia, diameter and formation of chlamydospores and interseptal distance. Five random readings were taken for each character studied and resulted mean of readings was calculated. Temporary glass slide mounts of each isolate were made in lactophenol solution and assessed under light microscope (Nikon YS100) at 100X magnification for observation of characters. The morphology study helped in grouping of the isolates into 31 type isolates. All these type isolates were selected for further characterization and confirmation at species level through DNA sequencing. Further, these were tested to characterize their virulence using pathogenicity assay.

$Molecular\ characterization$

Molecular study of the isolates was undertaken at the Department of Plant Pathology and Environmental Microbiology, Pennsylvania State University, USA,

Genomic DNA isolation

Fungal growth of each respective isolate was achieved on PDA plates after 7 days of incubation (25°C) in dark and scratched using sterilized surgical blade for transfer to 2 ml microcentrifuge tube. Glass beads (0.1 mm) were used for grinding of mycelia using beat beater and further DNA was extraction for amplification according to Cenis (1992) and Abd-Elsalam et al. (2003) with minor modifications. Yielded DNA of each isolate was checked for its quality through agarose gel electrophoresis along with concentration and purity through nanodrop spectrophotometer. This was followed by dissolution of each DNA in TE buffer and storage at -20 °C.

Polymerase chain reaction (PCR) and DNA sequencing

TEF-1 α region was amplified with the primers viz. ef1 (5'-ATGGGTAAGGA(A/G)GACAAGAC-3') and ef2 (5'-GGA(G/A)GTACCAGT(G/C)ATCATGTT-3') (Geiser *et al.*, 2004). Amplification (Williams *et al.*, 1990) was carried out in 50 µl of PCR reaction mixture containing 10X *Taq* Buffer (5 µl), 0.2 mM of dNTPs mix (100 mM of each dNTPs), 25 ng of both primers (1 µl), 0.6 U (0.3 µl) of *Taq* polymerase (New England Biolabs, Ipswich, MA) and 25 ng of template DNA.

The reaction mixture was subjected to PCR and consisted of an initial denaturation step for 4 min at 95°C, followed by 30 cycles of denaturation for 1 min at 95°C, annealing for 2 min at 53°C, extension at 72°C for 1 min and final extension at 72°C for 5 min. PCR products were separated electrophoretically through 1% agarose gels. Gels stained with ethidium bromide were visualized under Transilluminator and photographed. The resulting reaction amplicons were purified through ExoSap-IT (USB, Cleveland, USA) according to the manufacturer's instructions and sequencing of the purified amplicons was done from Genomics Core facility available at Pennsylvania State University, USA.

The sequenced data was edited using the software program Sequencher v.4.1.4 (Gene Codes Corp.). Each DNA sequence was blasted against NCBI (http://blast.ncbi.nlm.nih.gov) (Altschul *et al.*, 1997) and FUSARIUM-ID server (http://fusarium.cbio.psu.edu) (Geiser *et al.*, 2004) for species determination.

Phylogenetic analysis

Sequence data was aligned for each tested isolate using the multiple sequence alignment program at MAFFT website (http://mafft.cbrc.jp/alignment/software/macportabl e.html) (Katoh and Standley, 2013). Phylogenetic tree was constructed and analysis was executed through maximum likelihood-bootstrap (ML-BS) method with 1000 bootstrap replications using MEGA 6 software (Tamura *et al.*, 2013). The sequence types that had the highest sequence similarity to the isolates of the present study and those described by O'Donnell *et al.* (2013) were retrieved from the Genbank database and included in the phylogenetic analysis. *F. beomiforme* and *F. concolor* sequences (NRRL25174 and NRRL13459, respectively) for TEF-1α gene were used as the outgroup for rooting of the tree.

Pathogenicity test

Inoculum preparation and plant inoculation

For *in vitro* pathogenicity assay (Taheri *et al.*, 2010), each *F. oxysporum* isolate was grown in Erlenmeyer flasks (100 ml) containing potato-dextrose broth (50 ml). Mycelial plug (5 mm dia) taken from periphery of pure culture was inoculated in each flask followed by shaking of flasks in a rotary shaker (120 rpm) for 3 days. For inoculation, spore suspension of each isolate was adjusted to 1 x 10⁷conidia/ ml through haemocytometer.

For preparation of sterilized potting mixture, prepared formaldehyde (5%) solution from 37% commercial formulation (Merck, Germany) was mixed thoroughly with potting mixture (100 ml/ kg of soil). The mixture was covered properly with polythene sheets. After 2 days, the mixture was exposed to air, turned over and left uncovered for 5 days with to allow escape of formaldehyde fumes. The treated potting mixture was then used for partially filling each pot.

Lentil germplasm viz. line NARC-08-1 and cultivar Masoor-93 was used for the experiment. Lentil seeds were first surface sterilized using sodium hypochlorite (0.5%) for 2 minutes followed by rinsing in sterilized distilled water. After sterilization, seeds were sown in germinator trays filled with sterilized potting mixture composed of sand and farmyard manure (1:1) and watered. After 2 weeks, each seedling was uprooted carefully and dipped into the inoculum of each respective isolate for 10 minutes. After pathogen inoculation, seedlings were transplanted in plastic pots (5 seedlings per pot) filled with sterilized potting (sand/clay/farmyard manure, mixture 1:1:1). maintained in green house at 25±2°C and watered as required. The pots with plants inoculated with sterilized distilled water served as control. The experiment formed a completely randomized design (CRD) using 3 replications.

Disease assessment

Disease parameters viz. disease severity index, disease incidence and yield reduction were recorded after inoculation. Disease incidence was calculated using the formula as described above. The data on disease severity index was recorded at 2 to 3 days interval after 5th day of inoculation up till maturity. A 0-9 disease rating scale described by Bayaa *et al.* (1995) was followed with minor modification. According to this scale, o = no symptoms or infection, 1-3 = yellowing of the basal leaves only, 4-6 = yellowing of 50 percent of the foliage and 7-9 = complete yellowing of the foliage with whole plant or part of the plant wilted and/ or dried. The formula described by Kranz (1998) was then used to calculate the severity index percentage as,

Disease severity index (%) = Σ (a x b) x 100

N.Z

Where,

 Σ (a x b) = Sum of the symptomatic plant and their corresponding scale value.

N = Total number of plants per pot.

Z = Highest scale value.

Based on disease symptoms and the rating scale, the virulence of isolates was further characterized as avirulent (o scale value), low virulent (1-3 scale range), moderately virulent (4-6) and highly virulent (7-9). To fulfill Koch's postulates, re-isolations of the inoculated fungi were done at the end for confirmations of the associated wilt pathogens.

Statistical analysis of data

The mean data of disease parameters was calculated and subjected to statistical analysis through SPSS statistical software package. Subsequently, means were separated by the least significant difference (LSD) test (5%).

Results and discussion

Disease assessment and recovery of isolates

Extensive lentil wilt surveys were conducted during the years 2011-12 and 2012-13 in the major lentil growing districts of Punjab, Pakistan. All the surveyed districts showed 100% mean disease prevalence and 25.7% mean incidence. Maximum incidence was observed at district Layyah (75.95%) while minimum incidence was recorded in district Sialkot (6.75%). Rest of the districts showed mild incidence of disease viz. Chakwal (17.5%), Jhelum (21.4%), Gujrat (22.92%), Bhakkar (12.9%) and Khushab (22.5%). In a similar study, Chaudhary et al. (2010) recorded 0.7-9.3% mean plant mortality and an overall mean mortality of 6.3% due to lentil wilt-root rot incidence in 116 lentil growing districts of India. Likewise, in Syria Bayaa et al. (1986) found 2 to 70% wilted plants with a mean of 12% in 27 fields. Similarly, Hamdi and Hassanein (1996) showed 0.5 to 10% proportion of wilted plants in Egypt. Later, Belabid et al. (2000) observed high incidence of wilt in North-Western Algeria and found F. oxysporum as the major causal agent along with F. moniliforme and F. equiseti as the minor pathogens.

Varied number of lentil fields were identified in each district at different locations, such as, Chakwal (Bangali Gujar and Piplee), Jhelum (Pindi Gujran, Dhapai, Khaiwal, Morha Skeiha and Chanaal), Gujrat (Jalalpur jatan, Shergarh, Sombre, Naseera, Bhaddar and Lambray), Sialkot (Pasrur road and Chowinda), Lavyah (Chowk Azam and Karoor), Bhakkar (Arid Zone Research Institute) and Khushab (Nurpur, Adhikot and Hassan Pur Tiwana). In fields, the disease was observed in patches during both crop stages with maximum recovery of isolates attained at adult plant stage, which might be attributed to the presence of favorable temperature (24-27°C) at reproductive stage than at seedling stage (5-20°C) (Haqqani et al., 2000). The study recovered 105 isolates of F. oxysporum from visited locations of seven districts of Punjab, Pakistan as shown in Table 1.

Morphological characterization

Recovered 105 isolates of *Fusarium* were studied morphologically using various characters (Fig. 1 and

Table 2). Colony characters of the isolates showed fluffy growth pattern with white (91 isolates; 86.67%) to pinkish white (14; 13.33%) mycelial color. Violet (22; 20.95%) to dark violet (25; 23.81%) pigmentation was noted in some isolates as illustrated by Leslie and Summerell (2006). Absence of concentric rings was observed after 12 hours light/ dark cycles. Growth rate was observed for distinguishing slow and fast growing isolates (Summerell *et al.*, 2003) and it varied from 7 to 11 days at 25 °C. Isolate FWG22 took 7 days to fill 9 cm plate and proved to be fastest growing compared to the rest while isolates viz. FWL5, FWL8, FWL9 and FWL10 found slow growing and completed 9 cm growth in 11 days.

Table 1.	The details o	f Fusarium	oxysporum	f. sp.	lentis isolates	used in the	present study.

PWC5 Chakwal Bangali Gujar 54 PW20 Oldum Chanaal 2 PWC6 Chakwal Bangali Gujar 55 PWG1 Gujat Jalalpur jatan 3 PWC8 Chakwal Piplee 56 PWG2 Gujat Jalalpur jatan 5 PWC1 Chakwal Piplee 58 PWG2 Gujat Shergarh 6 FWC16 Chakwal Piplee 60 PWG2 Gujat Shergarh 7 FWG16 Chakwal Piplee 61 FWG7 Gujat Shergarh 8 FWG21 Chakwal Piplee 62 FWG16 Gujat Shergarh 9 FW13 Jalelum Pindi Gujan 64 FWG16 Gujat Lambray 10 FW13 Jalelum Pindi Gujan 66 FWG12 Gujat Lambray 12 FW13 Jalelum Pindi Gujan 68 FWG14 Gujat Lambray	No.	Isolate ID No.	District Origin	of Place of Collection	No.	Isolate No.	ID District of Origin	Place of Collection
2 PWC6 Chakwal Bingali Gujar 55 PWG1 Gujart Jalalpur jatan 3 PWC30 Chakwal Piplee 57 PWG2 Gujart Jalalpur jatan 5 PWC10 Chakwal Piplee 58 PWG2 Gujart Shergarh 6 PWC15 Chakwal Piplee 60 PWG6 Gujart Shergarh 7 PWC10 Chakwal Piplee 61 PWG2 Gujart Shergarh 9 PWC21 Chakwal Piplee 62 PWG8 Gujart Shergarh 10 PW14 Jelaum Pindi Gujan 63 PWG10 Gujart Naiseera 12 PW14 Jelaum Pindi Gujan 64 PWG10 Gujart Lambray 13 PW14 Jelaum Pindi Gujan 66 PWG12 Gujart Lambray 14 FW15 Jelaum Pindi Gujan 70 PWG14 Lambray	1	FWC5	Chakwal	Bangali Gujar	54	FWJ70	Jhelum	Chanaal
3 FWC8 Chakwal Piple 56 FWC2 Cujirat Jalalpur jatan 5 FWC31 Chakwal Piple 57 FWC3 Gujirat Shergarh 6 FWC15 Chakwal Piple 59 FWG5 Gujirat Shergarh 7 FWC16 Chakwal Piple 60 FWG2 Gujirat Shergarh 8 FWC22 Chakwal Piple 61 FWG7 Gujirat Shergarh 10 FW12 Jhelum Pindi Gujann 64 FWG10 Gujirat Nascera 13 FW14 Jhelum Pindi Gujann 66 FWG14 Gujirat Lambray 14 FW15 Jhelum Pindi Gujann 66 FWG14 Gujirat Lambray 15 FW16 Jhelum Dinglai 70 FWG16 Gujirat Lambray 16 FW17 Jhelum Dinglai 71 FWG16 Gujirat Lambray	2	FWC6	Chakwal	Bangali Gujar	55	FWG1	Gujrat	Jalalpur jatan
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6 FWC15 Chakwal Piple 59 FWG5 Gujat Shergarh 7 FWC16 Chakwal Piple 60 FWG6 Gujat Shergarh 8 FWC21 Chakwal Piple 62 FWG8 Gujat Shergarh 10 FWJ1 Jhelum Pindi Gujran 64 FWG9 Gujat Naseera 12 FWJ3 Jhelum Pindi Gujran 66 FWG11 Gujat Naseera 13 FWJ4 Jhelum Pindi Gujran 67 FWG13 Gujrat Lambray 14 FWJ5 Jhelum Pindi Gujran 68 FWG14 Gujrat Lambray 15 FWJ6 Jhelum Dhapai 70 FWG16 Gujrat Lambray 16 FWJ1 Jhelum Dhapai 71 FWG16 Gujrat Lambray 17 FWJ13 Jhelum Dhapai 73 FWG26 Gujrat Lambray	5	FWC11	Chakwal	Piplee	58	FWG4	Gujrat	Shergarh
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Int FW22 Jhelum Pindi Gujran 64 FWG11 Oujpat Naseera 12 FWJ3 Jhelum Pindi Gujran 65 FWG11 Gujrat Baddar 13 FWJ5 Jhelum Pindi Gujran 67 FWG13 Gujrat Lambray 14 FWJ6 Jhelum Pindi Gujran 68 FWG14 Gujrat Lambray 15 FWJ6 Jhelum Dhapai 70 FWG15 Gujrat Lambray 16 FWJ9 Jhelum Dhapai 71 FWG16 Gujrat Lambray 18 FWJ10 Jhelum Dhapai 72 FWG18 Gujrat Lambray 20 FWJ13 Jhelum Dhapai 75 FWG21 Gujrat Lambray 21 FWJ15 Jhelum Dhapai 76 FWG23 Gujrat Lambray 22 FWJ13 Jhelum Dhapai 77 FWG23 Gujrat Lambray <t< td=""><td>10</td><td>FWJ1</td><td>Jhelum</td><td>Pindi Gujran</td><td>63</td><td>FWG9</td><td>Gujrat</td><td>Sombre</td></t<>	10	FWJ1	Jhelum	Pindi Gujran	63	FWG9	Gujrat	Sombre
12FWJ3 BJhelumPindi Gujran 65 FWG11 FWG12GujratNascera13FWJ5JhelumPindi Gujran 66 FWG13GujratLambray14FWJ5JhelumPindi Gujran 67 FWG13GujratLambray15FWJ7JhelumPindi Gujran 69 FWG15GujratLambray16FWJ7JhelumDhapai 70 FWG16GujratLambray17FWJ3JhelumDhapai 71 FWG17GujratLambray18FWJ3JhelumDhapai 72 FWG18GujratLambray20FWJ10JhelumDhapai 73 FWG20GujratLambray21FWJ12JhelumDhapai 75 FWG21GujratLambray22FWJ13JhelumDhapai 76 FWG22GujratLambray23FWJ44JhelumDhapai 76 FWG23GujratLambray24FWJ35JhelumKhaival 80 FWG24GujratLambray25FWJ36JhelumKhaival 80 FWG25GujratLambray26FWJ35JhelumKhaival 83 FWS2SialkotPasrur, Field 127FWJ36JhelumKhaival 83 FWS2SialkotPasrur, Field 128FWJ39JhelumKhaival 83 FWS4SialkotPasrur, Field 129FWJ4	11	FWJ2	Jhelum	Pindi Gujran	64	FWG10	Gujrat	Naseera
13 FWJ4 Jhelum Pindi Gujran 66 FWG12 Gujrat Bhaddar 14 FWJ5 Jhelum Pindi Gujran 67 FWG13 Gujrat Lambray 15 FWJ6 Jhelum Pindi Gujran 68 FWG14 Gujrat Lambray 16 FWJ5 Jhelum Dhapai 70 FWG16 Gujrat Lambray 16 FWJ0 Jhelum Dhapai 71 FWG16 Gujrat Lambray 18 FWJ0 Jhelum Dhapai 72 FWG19 Gujrat Lambray 20 FWJ11 Jhelum Dhapai 73 FWG20 Gujrat Lambray 21 FWJ12 Jhelum Dhapai 75 FWG22 Gujrat Lambray 23 FWJ14 Jhelum Dhapai 76 FWG22 Gujrat Lambray 24 FWJ15 Jhelum Dhapai 78 FWG24 Gujrat Lambray 25 FWJ63 Jhelum Khaival 80 FWG25 Gujrat Lambray 26 FWJ35 Jhelum Khaival 81 FWS1 Sialkot Pasrur, Field 1 30 <td< td=""><td>12</td><td>FWJ3</td><td>Jhelum</td><td>Pindi Gujran</td><td>65</td><td>FWG11</td><td>Gujrat</td><td>Naseera</td></td<>	12	FWJ3	Jhelum	Pindi Gujran	65	FWG11	Gujrat	Naseera
14FWJ5JhelumPindi Gujran67FWG13GujratLambray16FWJ7JhelumPindi Gujran68FWG14GujratLambray17FWJ8JhelumDhapai70FWG15GujratLambray18FWJ9JhelumDhapai71FWG17GujratLambray19FWJ10JhelumDhapai72FWG18GujratLambray20FWJ11JhelumDhapai73FWG20GujratLambray21FWJ12JhelumDhapai75FWG20GujratLambray22FWJ14JhelumDhapai76FWG20GujratLambray23FWJ14JhelumDhapai77FWG23GujratLambray24FWJ5JhelumDhapai77FWG24GujratLambray25FWJ16JhelumDhapai77FWG25GujratLambray26FWJ35JhelumKhaival80FWG26GujratLambray27FWJ36JhelumKhaival81FWS1SialkotPasrur, Field 129FWJ39JhelumKhaival82FWS2SialkotPasrur, Field 129FWJ39JhelumKhaival83FWS3SialkotPasrur, Field 229FWJ40JhelumKhaival84FWS4SialkotPasrur, Field 229FWJ41JhelumKhaival85 <t< td=""><td>13</td><td>FWJ4</td><td>Jhelum</td><td>Pindi Gujran</td><td>66</td><td>FWG12</td><td>Gujrat</td><td>Bhaddar</td></t<>	13	FWJ4	Jhelum	Pindi Gujran	66	FWG12	Gujrat	Bhaddar
15 FWJ4 Jhelum Pindi Gujran 68 FWG14 Gujrat Lambray 17 FWJ8 Jhelum Dhapai 70 FWG16 Gujrat Lambray 18 FWJ9 Jhelum Dhapai 71 FWG17 Gujrat Lambray 19 FWJ10 Jhelum Dhapai 72 FWG16 Gujrat Lambray 20 FWJ11 Jhelum Dhapai 73 FWG10 Gujrat Lambray 21 FWJ12 Jhelum Dhapai 75 FWG21 Gujrat Lambray 22 FWJ13 Jhelum Dhapai 76 FWG22 Gujrat Lambray 23 FWJ35 Jhelum Dhapai 77 FWG22 Gujrat Lambray 24 FWJ35 Jhelum Khaival 80 FWG24 Gujrat Lambray 25 FWJ36 Jhelum Khaival 81 FWS1 Sialkot Pastur, Field 26 FWJ35 Jhelum Khaival 82 FWS3 Sialkot <td< td=""><td>14</td><td>FWJ5</td><td>Jhelum</td><td>Pindi Gujran</td><td>67</td><td>FWG13</td><td>Gujrat</td><td>Lambray</td></td<>	14	FWJ5	Jhelum	Pindi Gujran	67	FWG13	Gujrat	Lambray
16 FWJ7 Jhelum Pindi Gujaran 69 FWG15 Gujart Lambray 17 FWJ8 Jhelum Dhapai 70 FWG17 Gujart Lambray 18 FWJ9 Jhelum Dhapai 71 FWG17 Gujart Lambray 19 FWJ10 Jhelum Dhapai 72 FWG18 Gujart Lambray 20 FWJ11 Jhelum Dhapai 73 FWG20 Gujart Lambray 21 FWJ14 Jhelum Dhapai 75 FWG21 Gujart Lambray 22 FWJ15 Jhelum Dhapai 77 FWG23 Gujart Lambray 23 FWJ16 Jhelum Dhapai 77 FWG25 Gujart Lambray 24 FWJ35 Jhelum Khaival 80 FWG26 Gujart Lambray 27 FWJ36 Jhelum Khaival 81 FWS2 Sialkot Pasrur, Field 1 30 FWJ39 Jhelum Khaival 82 FWS2 Sialkot	15	FWJ6	Jhelum	Pindi Gujran	68	FWG14	Gujrat	Lambray
17 FW38 Jhelum Dhapai 70 FWG16 Gujrat Lambray 18 FWJ0 Jhelum Dhapai 71 FWG17 Gujrat Lambray 19 FWJ10 Jhelum Dhapai 72 FWG18 Gujrat Lambray 20 FWJ11 Jhelum Dhapai 73 FWG19 Gujrat Lambray 21 FWJ13 Jhelum Dhapai 75 FWG21 Gujrat Lambray 22 FWJ15 Jhelum Dhapai 76 FWG22 Gujrat Lambray 23 FWJ36 Jhelum Dhapai 76 FWG22 Gujrat Lambray 24 FWJ36 Jhelum Khaival 80 FWG24 Gujrat Lambray 25 FWJ36 Jhelum Khaival 80 FWS25 Gujrat Lambray 26 FWJ37 Jhelum Khaival 81 FWS1 Sialkot Pasrur, Field 1 29 FWJ38 Jhelum Khaival 82 FWS2 Sialkot P	16	FWJ7	Jhelum	Pindi Gujran	69	FWG15	Gujrat	Lambray
18 FWJ9 Jhelum Dhapai 71 FWG17 Gujrat Lambray 19 FWJ10 Jhelum Dhapai 72 FWG19 Gujrat Lambray 20 FWJ11 Jhelum Dhapai 73 FWG19 Gujrat Lambray 21 FWJ12 Jhelum Dhapai 74 FWG20 Gujrat Lambray 22 FWJ14 Jhelum Dhapai 76 FWG22 Gujrat Lambray 23 FWJ16 Jhelum Dhapai 77 FWG23 Gujrat Lambray 24 FWJ36 Jhelum Nhapai 78 FWG26 Gujrat Lambray 25 FVJ36 Jhelum Khaiwal 79 FWG26 Gujrat Lambray 26 FWJ37 Jhelum Khaiwal 81 FWS1 Sialkot Pasrur, Field 1 29 FWJ36 Jhelum Khaiwal 82 FWS2 Sialkot Pasrur, Field 1 31 FWJ40 Jhelum Khaiwal 82 FWS4 Sialkot	17	FWJ8	Jhelum	Dhapai	70	FWG16	Gujrat	Lambray
19 FWJ10 Jhelum Dhapai 72 FWG18 Gujrat Lambray 20 FWJ11 Jhelum Dhapai 73 FWG20 Gujrat Lambray 21 FWJ12 Jhelum Dhapai 75 FWG20 Gujrat Lambray 22 FWJ14 Jhelum Dhapai 75 FWG20 Gujrat Lambray 23 FWJ14 Jhelum Dhapai 75 FWG24 Gujrat Lambray 24 FWJ35 Jhelum Dhapai 77 FWG26 Gujrat Lambray 25 FWJ36 Jhelum Dhapai 78 FWG26 Gujrat Lambray 26 FWJ37 Jhelum Khaiwal 80 FWS26 Gujrat Lambray 27 FWJ36 Jhelum Khaiwal 82 FWS3 Sialkot Pasrur, Field 1 30 FWJ39 Jhelum Khaiwal 82 FWS3 Sialkot Pasrur, Field 2 31 FWJ40 Jhelum Khaiwal 85 FWS5 Sialkot	18	FWJ9	Jhelum	Dhapai	71	FWG17	Gujrat	Lambray
o FW311 Jhelum Dhapai 73 FWG19 Gujrat Lambray 21 FWJ12 Jhelum Dhapai 74 FWG20 Gujrat Lambray 22 FWJ13 Jhelum Dhapai 75 FWG21 Gujrat Lambray 23 FWJ16 Jhelum Dhapai 76 FWG22 Gujrat Lambray 24 FWJ16 Jhelum Dhapai 77 FWG23 Gujrat Lambray 25 FWJ16 Jhelum Khaiwal 79 FWG26 Gujrat Lambray 26 FWJ36 Jhelum Khaiwal 80 FWS2 Sialkot Pasrur, Field 1 29 FWJ38 Jhelum Khaiwal 82 FWS2 Sialkot Pasrur, Field 1 30 FWJ40 Jhelum Khaiwal 83 FWS3 Sialkot Pasrur, Field 2 31 FWJ40 Jhelum Khaiwal 85 FWS4 Sialkot Pasrur, Field 2 <td>19</td> <td>FWJ10</td> <td>Jhelum</td> <td>Dhapai</td> <td>72</td> <td>FWG18</td> <td>Gujrat</td> <td>Lambray</td>	19	FWJ10	Jhelum	Dhapai	72	FWG18	Gujrat	Lambray
PWJ12 Jhelum Dhapai 74 FWG20 Gujrat Lambray 22 FWJ13 Jhelum Dhapai 75 FWG21 Gujrat Lambray 23 FWJ14 Jhelum Dhapai 76 FWG22 Gujrat Lambray 24 FWJ15 Jhelum Dhapai 77 FWG23 Gujrat Lambray 25 FWJ16 Jhelum Dhapai 78 FWG24 Gujrat Lambray 26 FWJ35 Jhelum Khaival 79 FWG25 Gujrat Lambray 27 FWJ36 Jhelum Khaival 80 FWS2 Sialkot Pasrur, Field 1 29 FWJ38 Jhelum Khaival 82 FWS2 Sialkot Pasrur, Field 1 30 FWJ40 Jhelum Khaival 83 FWS3 Sialkot Pasrur, Field 1 31 FWJ40 Jhelum Khaival 85 FWS6 Sialkot Pasrur, Field 1 32 FWJ41 Jhelum Khaival 86 FWS6 Sialkot Pasrur, Field 2 33 FWJ42 Jhelum Khaival 87 FWS6 Sialkot Chowinda 34 <td>20</td> <td>FWJ11</td> <td>Jhelum</td> <td>Dhapai</td> <td>73</td> <td>FWG19</td> <td>Gujrat</td> <td>Lambray</td>	20	FWJ11	Jhelum	Dhapai	73	FWG19	Gujrat	Lambray
22 FWJ13 Jhelum Dhapai 75 FWG21 Gujrat Lambray 23 FWJ14 Jhelum Dhapai 76 FWG22 Gujrat Lambray 24 FWJ15 Jhelum Dhapai 77 FWG23 Gujrat Lambray 25 FWJ6 Jhelum Dhapai 78 FWG24 Gujrat Lambray 26 FWJ35 Jhelum Khaiwal 80 FWG26 Gujrat Lambray 27 FWJ36 Jhelum Khaiwal 81 FWS1 Sialkot Pasrur, Field 1 29 FWJ38 Jhelum Khaiwal 82 FWS2 Sialkot Pasrur, Field 1 30 FWJ39 Jhelum Khaiwal 83 FWS3 Sialkot Pasrur, Field 2 32 FWJ41 Jhelum Khaiwal 84 FWS6 Sialkot Pasrur, Field 2 33 FWJ42 Jhelum Khaiwal 85 FWS7 Sialkot Pasrur, Field 2 34 FWJ42 Jhelum Khaiwal 87 FWS9 Sialkot Chowinda 36 FWJ42 Jhelum Khaiwal 89 FWS9 Sialkot Chowinda <	21	FWJ12	Jhelum	Dhapai	74	FWG20	Gujrat	Lambray
33FWJ14JhelumDhapai76FWG22GujratLambray24FWJ15JhelumDhapai77FWG23GujratLambray25FWJ16JhelumKhaival79FWG24GujratLambray26FWJ35JhelumKhaival80FWG26GujratLambray27FWJ36JhelumKhaival81FWS1SialkotPasrur, Field 129FWJ37JhelumKhaival82FWS2SialkotPasrur, Field 130FWJ39JhelumKhaival83FWS3SialkotPasrur, Field 131FWJ40JhelumKhaival84FWS4SialkotPasrur, Field 232FWJ40JhelumKhaival85FWS5SialkotPasrur, Field 233FWJ42JhelumKhaival86FWS6SialkotPasrur, Field 234FWJ43JhelumKhaival87FWS7SialkotPasrur, Field 235FWJ44JhelumKhaival88FWS8SialkotChowinda36FWJ45JhelumKhaival90FWS10SialkotChowinda37FWJ46JhelumKhaival90FWL5LayyahChowk Azam39FWJ54JhelumMorha Skeiha91FWL5LayyahChowk Azam40FWJ56JhelumMorha Skeiha92FWL6LayyahChowk Azam41FWJ57	22	FWJ13	Jhelum	Dhapai	75	FWG21	Gujrat	Lambray
24FWJ15JhelumDhapai77FWG23GujratLambray25FWJ36JhelumKhaiwal79FWG25GujratLambray26FWJ35JhelumKhaiwal80FWG26GujratLambray28FW337JhelumKhaiwal80FWG26GujratLambray28FWJ37JhelumKhaiwal81FWS1SialkotPasrur, Field 130FWJ38JhelumKhaiwal82FWS2SialkotPasrur, Field 131FWJ39JhelumKhaiwal83FWS3SialkotPasrur, Field 232FWJ41JhelumKhaiwal85FWS5SialkotPasrur, Field 233FWJ42JhelumKhaiwal86FWS6SialkotPasrur, Field 234FWJ43JhelumKhaiwal88FWS8SialkotChowinda35FWJ44JhelumKhaiwal89FWS9SialkotChowinda36FWJ55JhelumKhaiwal90FWL50SialkotChowk Azam37FWJ56JhelumKhaiwal92FWL6LayyahChowk Azam38FWJ54JhelumMorha Skeiha91FWL5LayyahChowk Azam39FWJ56JhelumMorha Skeiha92FWL6LayyahChowk Azam41FWJ58JhelumMorha Skeiha95FWL9LayyahKaroor43FWJ60Jhelu	23	FWJ14	Jhelum	Dhapai	76	FWG22	Gujrat	Lambray
55 FWJi6 Jhelum Dhapai 78 FWG24 Gujrat Lambray 26 FWJ35 Jhelum Khaiwal 79 FWG26 Gujrat Lambray 27 FWJ36 Jhelum Khaiwal 80 FWS1 Sialkot Pasrur, Field 1 28 FWJ37 Jhelum Khaiwal 81 FWS1 Sialkot Pasrur, Field 1 29 FWJ38 Jhelum Khaiwal 82 FWS2 Sialkot Pasrur, Field 1 30 FWJ40 Jhelum Khaiwal 83 FWS3 Sialkot Pasrur, Field 1 31 FWJ40 Jhelum Khaiwal 85 FWS5 Sialkot Pasrur, Field 2 33 FWJ42 Jhelum Khaiwal 86 FWS6 Sialkot Pasrur, Field 2 35 FWJ43 Jhelum Khaiwal 87 FWS7 Sialkot Chowinda 36 FWJ43 Jhelum Khaiwal 89 FWS8 Sialkot Chowinda 37 FWJ46 Jhelum Morha Skeiha 91	24	FWJ15	Jhelum	Dhapai	77	FWG23	Gujrat	Lambray
66 FWJ35 Jhelum Khaiwal 79 FWG25 Gujrat Lambray 27 FWJ36 Jhelum Khaiwal 80 FWG26 Gujrat Lambray 28 FWJ37 Jhelum Khaiwal 81 FWS1 Sialkot Pasrur, Field 1 29 FWJ38 Jhelum Khaiwal 82 FWS2 Sialkot Pasrur, Field 1 30 FWJ39 Jhelum Khaiwal 83 FWS3 Sialkot Pasrur, Field 1 31 FWJ40 Jhelum Khaiwal 84 FWS5 Sialkot Pasrur, Field 2 32 FWJ41 Jhelum Khaiwal 85 FWS5 Sialkot Pasrur, Field 2 33 FWJ42 Jhelum Khaiwal 86 FWS7 Sialkot Pasrur, Field 2 34 FWJ43 Jhelum Khaiwal 89 FWS9 Sialkot Chowinda 35 FWJ44 Jhelum Khaiwal 90 FWS10 Sialkot Chowinda 36 FWJ35 Jhelum Morha Skeiha 91 <td>25</td> <td>FWJ16</td> <td>Jhelum</td> <td>Dhapai</td> <td>78</td> <td>FWG24</td> <td>Gujrat</td> <td>Lambray</td>	25	FWJ16	Jhelum	Dhapai	78	FWG24	Gujrat	Lambray
77FWJ36JhelumKhaiwal80FWG26GujratLambray28FWJ37JhelumKhaiwal81FWS1SialkotPasrur, Field 129FWJ38JhelumKhaiwal82FWS2SialkotPasrur, Field 130FWJ40JhelumKhaiwal83FWS3SialkotPasrur, Field 131FWJ40JhelumKhaiwal84FWS4SialkotPasrur, Field 232FWJ41JhelumKhaiwal85FWS5SialkotPasrur, Field 233FWJ42JhelumKhaiwal86FWS6SialkotPasrur, Field 234FWJ43JhelumKhaiwal87FWS7SialkotChowinda35FWJ44JhelumKhaiwal89FWS9SialkotChowinda36FWJ45JhelumKhaiwal90FWS10SialkotChowinda37FWJ46JhelumKhaiwal90FWL5LayyahChowk Azam39FWJ55JhelumMorha Skeiha91FWL5LayyahChowk Azam40FWJ56JhelumMorha Skeiha93FWL7LayyahChowk Azam41FWJ57JhelumMorha Skeiha94FWL8LayyahKaroor43FWJ59JhelumMorha Skeiha95FWL10LayyahKaroor44FWJ60JhelumMorha Skeiha96FWL10LayyahKaroor45FWJ6	26	FWJ35	Jhelum	Khaiwal	79	FWG25	Gujrat	Lambray
88FWJ37JhelumKhaiwal81FWS1SialkotPasrur, Field 129FWJ38JhelumKhaiwal82FWS2SialkotPasrur, Field 130FWJ39JhelumKhaiwal83FWS2SialkotPasrur, Field 131FWJ40JhelumKhaiwal84FWS4SialkotPasrur, Field 232FWJ41JhelumKhaiwal85FWS5SialkotPasrur, Field 233FWJ42JhelumKhaiwal86FWS6SialkotPasrur, Field 234FWJ43JhelumKhaiwal87FWS7SialkotPasrur, Field 235FWJ44JhelumKhaiwal89FWS9SialkotChowinda36FWJ45JhelumKhaiwal90FWS10SialkotChowinda37FWJ46JhelumKhaiwal90FW15LayyahChowk Azam39FWJ55JhelumMorha Skeiha91FW1.5LayyahChowk Azam41FWJ56JhelumMorha Skeiha93FW1.7LayyahChowk Azam41FWJ58JhelumMorha Skeiha94FW1.8LayyahKaroor43FWJ59JhelumMorha Skeiha97FW1.8LayyahKaroor44FWJ60JhelumMorha Skeiha97FW1.8LayyahKaroor41FWJ59JhelumMorha Skeiha97FW1.8LayyahKaroor4	27	FWJ36	Jhelum	Khaiwal	80	FWG26	Gujrat	Lambray
99FWJ38JhelumKhaiwal82FWS2SialkotPasrur, Field 130FWJ39JhelumKhaiwal83FWS3SialkotPasrur, Field 131FWJ40JhelumKhaiwal84FWS4SialkotPasrur, Field 232FWJ41JhelumKhaiwal85FWS5SialkotPasrur, Field 233FWJ42JhelumKhaiwal86FWS6SialkotPasrur, Field 234FWJ43JhelumKhaiwal87FWS7SialkotChowinda35FWJ44JhelumKhaiwal88FWS8SialkotChowinda36FWJ45JhelumKhaiwal89FWS9SialkotChowinda37FWJ46JhelumKhaiwal90FWS10SialkotChowinda38FWJ55JhelumMorha Skeiha91FWL5LayyahChowk Azam40FWJ56JhelumMorha Skeiha93FWL7LayyahChowk Azam41FWJ57JhelumMorha Skeiha94FWL8LayyahKaroor43FWJ59JhelumMorha Skeiha95FWL10LayyahKaroor44FWJ60JhelumMorha Skeiha97FWL10LayyahKaroor45FWJ61JhelumMorha Skeiha97FWL12LayyahKaroor46FWJ62JhelumMorha Skeiha97FWL12LayyahKaroor47FWJ63	28	FWJ37	Jhelum	Khaiwal	81	FWS1	Sialkot	Pasrur, Field 1
30FW39JhelumKhaiwal83FWS3SialkotPasrur, Field 131FWJ40JhelumKhaiwal84FWS4SialkotPasrur, Field 232FWJ41JhelumKhaiwal85FWS5SialkotPasrur, Field 233FWJ42JhelumKhaiwal86FWS6SialkotPasrur, Field 234FWJ43JhelumKhaiwal87FWS7SialkotPasrur, Field 235FWJ44JhelumKhaiwal88FWS8SialkotChowinda36FWJ45JhelumKhaiwal89FWS9SialkotChowinda37FWJ46JhelumKhaiwal90FWS10SialkotChowinda38FWJ55JhelumMorha Skeiha91FWL5LayyahChowk Azam40FWJ56JhelumMorha Skeiha92FWL6LayyahChowk Azam41FWJ57JhelumMorha Skeiha93FWL7LayyahChowk Azam42FWJ58JhelumMorha Skeiha95FWL9LayyahKaroor43FWJ59JhelumMorha Skeiha95FWL10LayyahKaroor44FWJ60JhelumMorha Skeiha96FWL10LayyahKaroor45FWJ61JhelumMorha Skeiha97FWL12LayyahKaroor45FWJ63JhelumMorha Skeiha98FWL10LayyahKaroor46	29	FWJ38	Jhelum	Khaiwal	82	FWS2	Sialkot	Pasrur, Field 1
31FWJ40JhelumKhaiwal84FWS4SialkotPasrur, Field 232FWJ41JhelumKhaiwal85FWS5SialkotPasrur, Field 233FWJ42JhelumKhaiwal86FWS6SialkotPasrur, Field 234FWJ43JhelumKhaiwal87FWS7SialkotPasrur, Field 235FWJ44JhelumKhaiwal88FWS8SialkotChowinda36FWJ45JhelumKhaiwal89FWS9SialkotChowinda37FWJ46JhelumKhaiwal90FWS10SialkotChowinda38FWJ54JhelumMorha Skeiha91FWL5LayyahChowk Azam40FWJ55JhelumMorha Skeiha92FWL6LayyahChowk Azam41FWJ57JhelumMorha Skeiha93FWL7LayyahChowk Azam42FWJ58JhelumMorha Skeiha95FWL0LayyahKaroor43FWJ59JhelumMorha Skeiha96FWL10LayyahKaroor44FWJ60JhelumMorha Skeiha97FWL12LayyahKaroor45FWJ61JhelumMorha Skeiha98FWL13LayyahKaroor45FWJ63JhelumChanaal100FWL14LayyahKaroor46FWJ62JhelumChanaal101FWL5LayyahKaroor47FWJ63 <t< td=""><td>30</td><td>FWJ39</td><td>Jhelum</td><td>Khaiwal</td><td>83</td><td>FWS3</td><td>Sialkot</td><td>Pasrur, Field 1</td></t<>	30	FWJ39	Jhelum	Khaiwal	83	FWS3	Sialkot	Pasrur, Field 1
32FWJ41JhelumKhaiwal85FWS5SialkotPasrur, Field 233FWJ42JhelumKhaiwal86FWS6SialkotPasrur, Field 234FWJ43JhelumKhaiwal87FWS7SialkotPasrur, Field 235FWJ44JhelumKhaiwal88FWS8SialkotChowinda36FWJ45JhelumKhaiwal89FWS9SialkotChowinda37FWJ46JhelumKhaiwal90FWS10SialkotChowinda38FWJ54JhelumMorha Skeiha91FWL5LayyahChowk Azam39FWJ55JhelumMorha Skeiha92FWL6LayyahChowk Azam40FWJ56JhelumMorha Skeiha93FWL7LayyahChowk Azam41FWJ57JhelumMorha Skeiha94FWL8LayyahChowk Azam42FWJ58JhelumMorha Skeiha95FWL9LayyahKaroor43FWJ59JhelumMorha Skeiha96FWL10LayyahKaroor44FWJ60JhelumMorha Skeiha97FWL12LayyahKaroor45FWJ61JhelumMorha Skeiha98FWL13LayyahKaroor46FWJ62JhelumChanaal100FWL15LayyahKaroor47FWJ63JhelumChanaal101FWL16LayyahKaroor50FWJ64 <t< td=""><td>31</td><td>FWJ40</td><td>Jhelum</td><td>Khaiwal</td><td>84</td><td>FWS4</td><td>Sialkot</td><td>Pasrur, Field 2</td></t<>	31	FWJ40	Jhelum	Khaiwal	84	FWS4	Sialkot	Pasrur, Field 2
33FWJ42JhelumKhaiwal86FWS6SialkotPasrur, Field 234FWJ43JhelumKhaiwal87FWS7SialkotPasrur, Field 235FWJ44JhelumKhaiwal88FWS8SialkotChowinda36FWJ45JhelumKhaiwal89FWS9SialkotChowinda37FWJ46JhelumKhaiwal90FWS10SialkotChowinda38FWJ54JhelumMorha Skeiha91FWL5LayyahChowk Azam39FWJ55JhelumMorha Skeiha92FWL6LayyahChowk Azam40FWJ56JhelumMorha Skeiha93FWL7LayyahChowk Azam41FWJ57JhelumMorha Skeiha94FWL8LayyahChowk Azam42FWJ58JhelumMorha Skeiha95FWL9LayyahKaroor43FWJ60JhelumMorha Skeiha96FWL10LayyahKaroor44FWJ60JhelumMorha Skeiha97FWL12LayyahKaroor45FWJ61JhelumMorha Skeiha98FWL13LayyahKaroor46FWJ62JhelumChanaal100FWL15LayyahKaroor47FWJ63JhelumChanaal101FWL16LayyahKaroor49FWJ64JhelumChanaal102FWB10BhakkarArid Zone Research Institute50 </td <td>32</td> <td>FWJ41</td> <td>Jhelum</td> <td>Khaiwal</td> <td>85</td> <td>FWS5</td> <td>Sialkot</td> <td>Pasrur, Field 2</td>	32	FWJ41	Jhelum	Khaiwal	85	FWS5	Sialkot	Pasrur, Field 2
34FWJ43JhelumKhaiwal87FWS7SialkotPasrur, Field 235FWJ44JhelumKhaiwal88FWS8SialkotChowinda36FWJ45JhelumKhaiwal89FWS9SialkotChowinda37FWJ46JhelumKhaiwal90FWS10SialkotChowinda38FWJ54JhelumMorha Skeiha91FWL5LayyahChowk Azam39FWJ55JhelumMorha Skeiha92FWL6LayyahChowk Azam40FWJ56JhelumMorha Skeiha93FWL7LayyahChowk Azam41FWJ57JhelumMorha Skeiha95FWL9LayyahChowk Azam42FWJ58JhelumMorha Skeiha95FWL9LayyahKaroor43FWJ59JhelumMorha Skeiha96FWL10LayyahKaroor44FWJ60JhelumMorha Skeiha96FWL10LayyahKaroor45FWJ61JhelumMorha Skeiha98FWL113LayyahKaroor46FWJ62JhelumChanaal99FWL14LayyahKaroor48FWJ64JhelumChanaal100FWL15LayyahKaroor49FWJ65JhelumChanaal102FWB10BhakkarArid Zone Research Institute50FWJ66JhelumChanaal103FWK1KhushabNurpur51F	33	FWJ42	Jhelum	Khaiwal	86	FWS6	Sialkot	Pasrur, Field 2
35FWJ44JhelumKhaiwal88FWS8SialkotChowinda36FWJ45JhelumKhaiwal89FWS9SialkotChowinda37FWJ46JhelumKhaiwal90FWS10SialkotChowinda38FWJ54JhelumMorha Skeiha91FWL5LayyahChowk Azam39FWJ55JhelumMorha Skeiha92FWL6LayyahChowk Azam40FWJ56JhelumMorha Skeiha93FWL7LayyahChowk Azam41FWJ57JhelumMorha Skeiha94FWL8LayyahChowk Azam42FWJ58JhelumMorha Skeiha95FWL9LayyahKaroor43FWJ59JhelumMorha Skeiha96FWL10LayyahKaroor44FWJ60JhelumMorha Skeiha97FWL12LayyahKaroor45FWJ61JhelumMorha Skeiha98FWL13LayyahKaroor46FWJ63JhelumChanaal99FWL14LayyahKaroor47FWJ63JhelumChanaal100FWL16LayyahKaroor49FWJ65JhelumChanaal102FWB10BhakkarArid Zone Research Institute50FWJ66JhelumChanaal103FWK1KhushabNurpur51FWJ63JhelumChanaal104FWK2KhushabAdhikot52FWJ68 <td>34</td> <td>FWJ43</td> <td>Jhelum</td> <td>Khaiwal</td> <td>87</td> <td>FWS7</td> <td>Sialkot</td> <td>Pasrur, Field 2</td>	34	FWJ43	Jhelum	Khaiwal	87	FWS7	Sialkot	Pasrur, Field 2
36FWJ45JhelumKhaiwal89FWS9SialkotChowinda37FWJ46JhelumKhaiwal90FWS10SialkotChowinda38FWJ54JhelumMorha Skeiha91FWL5LayyahChowk Azam39FWJ55JhelumMorha Skeiha92FWL6LayyahChowk Azam40FWJ56JhelumMorha Skeiha93FWL7LayyahChowk Azam41FWJ57JhelumMorha Skeiha94FWL8LayyahChowk Azam42FWJ58JhelumMorha Skeiha95FWL9LayyahKaroor43FWJ59JhelumMorha Skeiha96FWL10LayyahKaroor44FWJ60JhelumMorha Skeiha97FWL12LayyahKaroor45FWJ61JhelumMorha Skeiha98FWL13LayyahKaroor46FWJ62JhelumChanaal99FWL14LayyahKaroor48FWJ63JhelumChanaal100FWL15LayyahKaroor49FWJ65JhelumChanaal102FWB10BhakkarArid Zone Research Institute50FWJ66JhelumChanaal103FWK1KhushabNurpur51FWJ67JhelumChanaal104FWS2KhushabAdhikot52FWJ68JhelumChanaal105FWK3KhushabHassan Pur Tiwana53 <td< td=""><td>35</td><td>FWJ44</td><td>Jhelum</td><td>Khaiwal</td><td>88</td><td>FWS8</td><td>Sialkot</td><td>Chowinda</td></td<>	35	FWJ44	Jhelum	Khaiwal	88	FWS8	Sialkot	Chowinda
37FWJ46JhelumKhaiwal90FWS10SialkotChowinda38FWJ54JhelumMorha Skeiha91FWL5LayyahChowk Azam39FWJ55JhelumMorha Skeiha92FWL6LayyahChowk Azam40FWJ56JhelumMorha Skeiha93FWL7LayyahChowk Azam41FWJ57JhelumMorha Skeiha94FWL8LayyahChowk Azam42FWJ58JhelumMorha Skeiha95FWL9LayyahKaroor43FWJ59JhelumMorha Skeiha96FWL10LayyahKaroor44FWJ60JhelumMorha Skeiha96FWL12LayyahKaroor45FWJ61JhelumMorha Skeiha97FWL12LayyahKaroor46FWJ62JhelumChanaal99FWL14LayyahKaroor47FWJ63JhelumChanaal100FWL15LayyahKaroor48FWJ64JhelumChanaal101FWL16LayyahKaroor50FWJ66JhelumChanaal102FWB10BhakkarArid Zone Research Institute51FWJ68JhelumChanaal104FWK2KhushabAdhikot52FWJ68JhelumChanaal105FWK3KhushabHassan Pur Tiwana53FWJ69JhelumChanaal105FWK3KhushabHassan Pur Tiwana	36	FWJ45	Jhelum	Khaiwal	89	FWS9	Sialkot	Chowinda
38FWJ54JhelumMorha Skeiha91FWL5LayyahChowk Azam39FWJ55JhelumMorha Skeiha92FWL6LayyahChowk Azam40FWJ56JhelumMorha Skeiha93FWL7LayyahChowk Azam41FWJ57JhelumMorha Skeiha94FWL8LayyahChowk Azam42FWJ58JhelumMorha Skeiha95FWL9LayyahKaroor43FWJ59JhelumMorha Skeiha96FWL10LayyahKaroor44FWJ60JhelumMorha Skeiha96FWL12LayyahKaroor45FWJ61JhelumMorha Skeiha98FWL13LayyahKaroor46FWJ62JhelumChanaal99FWL14LayyahKaroor47FWJ63JhelumChanaal100FWL15LayyahKaroor48FWJ64JhelumChanaal101FWL16LayyahKaroor50FWJ66JhelumChanaal103FWK1KhushabNurpur51FWJ68JhelumChanaal104FWK2KhushabAdhikot52FWJ68JhelumChanaal105FWK3KhushabHassan Pur Tiwana53FWJ69JhelumChanaal105FWK3KhushabHassan Pur Tiwana	37	FWJ46	Jhelum	Khaiwal	90	FWS10	Sialkot	Chowinda
39FWJ55JhelumMorha Skeiha92FWL6LayyahChowk Azam40FWJ56JhelumMorha Skeiha93FWL7LayyahChowk Azam41FWJ57JhelumMorha Skeiha94FWL8LayyahChowk Azam42FWJ58JhelumMorha Skeiha95FWL9LayyahKaroor43FWJ59JhelumMorha Skeiha96FWL10LayyahKaroor44FWJ60JhelumMorha Skeiha96FWL10LayyahKaroor45FWJ61JhelumMorha Skeiha98FWL13LayyahKaroor46FWJ62JhelumChanaal99FWL14LayyahKaroor47FWJ63JhelumChanaal100FWL15LayyahKaroor48FWJ64JhelumChanaal101FWL16LayyahKaroor50FWJ66JhelumChanaal103FWK1KhushabNurpur51FWJ68JhelumChanaal105FWK3KhushabHassan Pur Tiwana53FWJ69JhelumChanaal105FWK3KhushabHassan Pur Tiwana	38	FWJ54	Jhelum	Morha Skeiha	91	FWL5	Layyah	Chowk Azam
40FWJ56JhelumMorha Skeiha93FWL7LayyahChowk Azam41FWJ57JhelumMorha Skeiha94FWL8LayyahChowk Azam42FWJ58JhelumMorha Skeiha95FWL9LayyahKaroor43FWJ59JhelumMorha Skeiha96FWL10LayyahKaroor44FWJ60JhelumMorha Skeiha96FWL10LayyahKaroor45FWJ61JhelumMorha Skeiha97FWL12LayyahKaroor46FWJ62JhelumChanaal99FWL14LayyahKaroor47FWJ63JhelumChanaal100FWL15LayyahKaroor48FWJ64JhelumChanaal101FWL16LayyahKaroor50FWJ66JhelumChanaal103FWK1KhushabNurpur51FWJ68JhelumChanaal105FWK3KhushabHassan Pur Tiwana53FWJ69JhelumChanaal105FWK3KhushabHassan Pur Tiwana	39	FWJ55	Jhelum	Morha Skeiha	92	FWL6	Layyah	Chowk Azam
41FWJ57JhelumMorha Skeiha94FWL8LayyahChowk Azam42FWJ58JhelumMorha Skeiha95FWL9LayyahKaroor43FWJ59JhelumMorha Skeiha96FWL10LayyahKaroor44FWJ60JhelumMorha Skeiha97FWL12LayyahKaroor45FWJ61JhelumMorha Skeiha98FWL13LayyahKaroor46FWJ62JhelumChanaal99FWL14LayyahKaroor47FWJ63JhelumChanaal100FWL15LayyahKaroor48FWJ64JhelumChanaal101FWL16LayyahKaroor49FWJ65JhelumChanaal102FWB10BhakkarArid Zone Research Institute50FWJ66JhelumChanaal103FWK1KhushabNurpur51FWJ68JhelumChanaal105FWK3KhushabHassan Pur Tiwana53FWJ69JhelumChanaal105FWK3KhushabHassan Pur Tiwana	40	FWJ56	Jhelum	Morha Skeiha	93	FWL7	Layyah	Chowk Azam
42FWJ58JhelumMorha Skeiha95FWL9LayyahKaroor43FWJ59JhelumMorha Skeiha96FWL10LayyahKaroor44FWJ60JhelumMorha Skeiha97FWL12LayyahKaroor45FWJ61JhelumMorha Skeiha98FWL13LayyahKaroor46FWJ62JhelumChanaal99FWL14LayyahKaroor47FWJ63JhelumChanaal100FWL15LayyahKaroor48FWJ64JhelumChanaal101FWL16LayyahKaroor49FWJ65JhelumChanaal102FWB10BhakkarArid Zone Research Institute50FWJ66JhelumChanaal103FWK1KhushabNurpur51FWJ68JhelumChanaal105FWK3KhushabHassan Pur Tiwana53FWJ69JhelumChanaal105FWK3KhushabHassan Pur Tiwana	41	FWJ57	Jhelum	Morha Skeiha	94	FWL8	Layyah	Chowk Azam
43FWJ59JhelumMorha Skeiha96FWL10LayyahKaroor44FWJ60JhelumMorha Skeiha97FWL12LayyahKaroor45FWJ61JhelumMorha Skeiha98FWL13LayyahKaroor46FWJ62JhelumChanaal99FWL14LayyahKaroor47FWJ63JhelumChanaal100FWL15LayyahKaroor48FWJ64JhelumChanaal101FWL16LayyahKaroor49FWJ65JhelumChanaal102FWB10BhakkarArid Zone Research Institute50FWJ66JhelumChanaal103FWK1KhushabNurpur51FWJ68JhelumChanaal105FWK3KhushabHassan Pur Tiwana53FWJ69JhelumChanaal105FWK3KhushabHassan Pur Tiwana	42	FWJ58	Jhelum	Morha Skeiha	95	FWL9	Layyah	Karoor
44FWJ60JhelumMorha Skeiha97FWL12LayyahKaroor45FWJ61JhelumMorha Skeiha98FWL13LayyahKaroor46FWJ62JhelumChanaal99FWL14LayyahKaroor47FWJ63JhelumChanaal100FWL15LayyahKaroor48FWJ64JhelumChanaal101FWL16LayyahKaroor49FWJ65JhelumChanaal102FWB10BhakkarArid Zone Research Institute50FWJ66JhelumChanaal103FWK1KhushabNurpur51FWJ68JhelumChanaal105FWK3KhushabHassan Pur Tiwana53FWJ69JhelumChanaal105FWK3KhushabHassan Pur Tiwana	43	FWJ59	Jhelum	Morha Skeiha	96	FWL10	Layyah	Karoor
45FWJ61JhelumMorha Skeiha98FWL13LayyahKaroor46FWJ62JhelumChanaal99FWL14LayyahKaroor47FWJ63JhelumChanaal100FWL15LayyahKaroor48FWJ64JhelumChanaal101FWL16LayyahKaroor49FWJ65JhelumChanaal102FWB10BhakkarArid Zone Research Institute50FWJ66JhelumChanaal103FWK1KhushabNurpur51FWJ67JhelumChanaal104FWK2KhushabAdhikot52FWJ68JhelumChanaal105FWK3KhushabHassan Pur Tiwana53FWJ69JhelumChanaal105FWK3KhushabHassan Pur Tiwana	44	FWJ60	Jhelum	Morha Skeiha	97	FWL12	Layyah	Karoor
46FWJ62JhelumChanaal99FWL14LayyahKaroor47FWJ63JhelumChanaal100FWL15LayyahKaroor48FWJ64JhelumChanaal101FWL16LayyahKaroor49FWJ65JhelumChanaal102FWB10BhakkarArid Zone Research Institute50FWJ66JhelumChanaal103FWK1KhushabNurpur51FWJ67JhelumChanaal104FWK2KhushabAdhikot52FWJ68JhelumChanaal105FWK3KhushabHassan Pur Tiwana53FWJ69JhelumChanaal105FWK3KhushabHassan Pur Tiwana	45	FWJ61	Jhelum	Morha Skeiha	98	FWL13	Layyah	Karoor
47FWJ63JhelumChanaal100FWL15LayyahKaroor48FWJ64JhelumChanaal101FWL16LayyahKaroor49FWJ65JhelumChanaal102FWB10BhakkarArid ZoneResearch50FWJ66JhelumChanaal103FWK1KhushabNurpur51FWJ67JhelumChanaal104FWK2KhushabAdhikot52FWJ68JhelumChanaal105FWK3KhushabHassan Pur Tiwana53FWJ69JhelumChanaal105FWK3KhushabHassan Pur Tiwana	46	FWJ62	Jhelum	Chanaal	99	FWL14	Layyah	Karoor
48FWJ64JhelumChanaal101FWL16LayyahKaroor49FWJ65JhelumChanaal102FWB10BhakkarArid ZoneResearch50FWJ66JhelumChanaal103FWK1KhushabNurpur51FWJ67JhelumChanaal104FWK2KhushabAdhikot52FWJ68JhelumChanaal105FWK3KhushabHassan Pur Tiwana53FWJ69JhelumChanaal105FWK3KhushabHassan Pur Tiwana	47	FWJ63	Jhelum	Chanaal	100	FWL15	Layyah	Karoor
49FWJ65JhelumChanaal102FWB10BhakkarAridZoneResearch50FWJ66JhelumChanaal103FWK1KhushabNurpur51FWJ67JhelumChanaal104FWK2KhushabAdhikot52FWJ68JhelumChanaal105FWK3KhushabHassan Pur Tiwana53FWJ69JhelumChanaal105FWK3KhushabHassan Pur Tiwana	48	FWJ64	Jhelum	Chanaal	101	FWL16	Layyah	Karoor
50FWJ66JhelumChanaal103FWK1KhushabNurpur51FWJ67JhelumChanaal104FWK2KhushabAdhikot52FWJ68JhelumChanaal105FWK3KhushabHassan Pur Tiwana53FWJ69JhelumChanaal105FWK3KhushabHassan Pur Tiwana	49	FWJ65	Jhelum	Chanaal	102	FWB10	Bhakkar	Arid Zone Research Institute
51FWJ67JhelumChanaal104FWK2KhushabAdhikot52FWJ68JhelumChanaal105FWK3KhushabHassan Pur Tiwana53FWJ69JhelumChanaal105FWK3KhushabHassan Pur Tiwana	50	FWJ66	Jhelum	Chanaal	103	FWK1	Khushab	Nurpur
52 FWJ68 Jhelum Chanaal 105 FWK3 Khushab Hassan Pur Tiwana 53 FWJ69 Jhelum Chanaal 105 FWK3 Khushab Hassan Pur Tiwana	51	FWJ67	Jhelum	Chanaal	104	FWK2	Khushab	Adhikot
53 FWJ69 Jhelum Chanaal	52	FWJ68	Jhelum	Chanaal	105	FWK3	Khushab	Hassan Pur Tiwana
	53	FWJ69	Jhelum	Chanaal		5		

Microscopic examination of the isolates showed hyaline, branched and septate conidiophores (Nelson *et al.*, 1983; Gupta *et al.*, 1986; Leslie and Summerell, 2006) with interseptal distance measured ranged from 7.8 \pm 3.11 (FWC11) to 31.0 \pm 10.29 µm (FWG1). Straight, three to four-septate and thin-walled macroconidia, a character of *F. oxysporum* was noted in the

study as proposed by Nelson *et al.* (1983) and Leslie and Summerell (2006). The conidial size varied and ranged from 8.0 ± 1.17 (FWL6) to 29.6 ± 5.18 µm (FWC21) in length and 2.0 ± 0 (FWJ15 and FWL8) to 4.0 ± 0.35 µm (FWC11) in width. Similar variability in size of conidia has been indicated in a study by Booth (1977) and Mandhare *et al.* (2011).

Table 2. Morphological characterization of Fusarium oxysporum isolates.

No.	Isolate I	D Colony	Pigmentation	D	Macro-con	idia		Micro-coni	lia		Chlamydos	pores	Interseptal
	No.	color			Length (um)	Width (um)	S	Length (um)	Width (um)	Shape	Diameter (um)	Formation	distance (µm)
1	FWC5	White	Dark Violet	9	13.8±2.68	2.4±0.22	3-4	4.5±0.71	2±0	2-celled Oval	8.6±0.89	Singly, Pairs	11±4.47
2	FWC6	White	Dark Violet	9	17.8±2.28	3±0	3	5.8±0.84	2.2±0.45	Oval	8.6±0.89	Singly, Pairs	23.6±5.59
3	FWC8	White	-	9	19.8±2.68	3.8±1.30	3	6.9±2.07	2.8±0.27	Oval	7.4±1.67	Singly, Pairs	16.6±6.88
4	FWC10	White	-	8	22.4±5.17	3.3±0.45	3	8.8±1.30	2.9±0.22	Oval	7.8±1.09	Singly, Pairs	10.2±3.49
5	FWC11	White	Violet	9	24.6±3.57	4±0.35	3	5.4±0.89	2.2±0.45	2-celled Oval	11.4±2.79	Singly, Pairs	7.8±3.11
6	FWC15	White	Dark Violet	8	26.2±4.02	3.2±0.45	3	6.8±0.84	2.8±0.27	Oval	14±4	Singly, Pairs	19.4±4.09
7	FWC16	White	Dark Violet	8	25±8.77	3.7±0.83	3	7.8±1.48	2.3±0.27	Oval	7±1.41	Singly, Pairs	18.4±7.30
8	FWC21	White	-	9	29.6±5.18	3.6±0.55	3	8.2±1.48	2.9±0.22	Oval	12±4.74	Singly, Pairs	21.1±2.75
9	FWC22	White	-	ģ	25±7.681	3.2±0.67	3	6.6±0.89	2.5±0	Oval	12.6±3.37	Singly, Pairs	17.2±5.17
10	FWJ1	White	-	10	18.8+2.28	2.8±0.27	3	6.4+1.14	2.2±0.27	2-celled Oval	15±5.09	Singly, Pairs	18.6±6.23
11	FWJ2	Pinkish	-	9	18+3.16	2.6±0.42	3	7.1±2.07	2±0	2-celled Oval	10.8±3.03	Singly, Pairs	15.6±6.23
		White		,			0	,,				8-,,	-0.0-00
12	FWJ3	Pinkish White	Dark Violet	9	13.2±3.56	2.3±0.27	3	6.8±0.84	2.1±0.22	2-celled Oval	7.8±1.48	Singly, Pairs	10.6±3.36
13	FWJ4	White	Dark Violet	9	15.2±2.28	2.8±0.27	3	5.4±0.55	2.1±0.22	Oval	10.4±1.52	Singly, Pairs	16±2.24
14	FWJ5	Pinkish White	-	9	15±4.79	2.5±0.35	3	4.4±0.55	2.5±0	Oval	9±0.71	Singly, Pairs	16.4±5.73
15	FWJ6	White	Violet	9	17.4±2.79	2.9±0.22	3	5±0.71	2.5±0	Oval	10.2±1.30	Singly, Pairs	14.8±5.02
16	FWJ7	White	-	9	20±1.41	3±0	3	4.6±0.55	2.6±0.22	Oval	10.8±1.30	Singly, Pairs	9.4±2.61
17	FWJ8	White	Violet	8	12.2±1.89	2.5±0	3	5.1±0.22	2.5±0.87	Oval	9.6±2.61	Singly	17.6±3.85
18	FWJ9	White	Violet	8	15.6±7.64	2.7±0.45	3	5.9±0.74	2.65±0.22	Oval	11.2±2.59	Singly	18.2±6.49
19	FWJ10	White	Dark Violet	8	18±3.46	2.6±0.41	3	5.8±0.87	2.5±0.35	Oval	11.2±5.06	Singly	13.6±3.51
20	FWJ11	Pinkish	-	8	11±1.41	2.4±0.41	3-4	5.3±0.45	2.05±0.59	Oval	11±1	Singly	11±6.48
		White					0.	0.0 . 10				- 87	
21	FWJ12	Pinkish White	-	9	14.6±4.34	2.2±0.27	3-4	6.6±0.89	2.75±0.25	Oval	14±3.16	Singly	19.6±3.29
22	FWJ13	White	-	8	17.4±7.33	2.5±0.35	3-4	6.6±0.89	2.3±0.27	Oval	10.4±1.67	Singly	17.2±9.65
23	FWJ14	Pinkish White	Dark Violet	8	19.6±5.13	2.3±0.27	3	7.2±0.84	2±0	Oval	11.4±1.67	Singly, Pairs	14.3±4.12
24	FWJ15	Pinkish White	Dark Violet	8	10.8±2.28	2±0	3	6.6±1.34	2.5±0	Oval	12±4.74	Singly, Pairs	17.6±8.08
25	FWJ16	Pinkish White	-	9	19.4±7.13	2.4±0.42	3	7±0.71	2.1±0.22	Oval	9.4±1.34	Singly, Pairs	18±10.07
26	FWJ35	White	Dark Violet	8	26±8.37	3±0.35	3	6.4±1.14	2.5±0.5	Oval	7.2±1.30	Singly, Pairs	10.6±0.89
27	FWJ36	White	Violet	8	12.6±3.29	2.5±0	3	5.4±1.14	2.3±0.45	Oval	10.4±2.61	Singly, Pairs	12.8±4.55
28	FWJ37	White	Violet	8	17.6±3.21	2.6±0.22	3	5.2±0.84	2.2±0.45	Oval	11.2±3.83	Singly, Pairs	12.6±3.78
29	FWJ38	White	Violet	8	18.3±1.79	2.5±0	3	4.6±1.34	2.3±0.45	Oval	12.4±3.85	Singly, Pairs	12.2±4.71
30	FWJ39	White	Violet	8	20.4±4.84	2.5±0	3	5.8±0.84	2.1±0.22	Oval	11±2.65	Singly, Pairs	14.6±4.77
31	FWJ40	White	-	8	21.8±6.09	2.7±0.45	3	5.4±0.55	2.1±0.22	Oval	14.4±4.39	Singly, Pairs	15.4±5.13
32	FWJ41	White	-	8	16.8±5.93	2.5±0.18	3	5.8±0.45	2.4±0.42	Oval	13.8±4.15	Singly, Pairs	19.6±7.92
33	FWJ42	White	-	8	19.1±4.85	2.5±0	3	5.2±0.84	2.6±0.55	Oval	13±3.61	Singly, Pairs	17.2±6.22
34	FWJ43	White	-	8	20.8±3.03	2.55±0.11	3	5±0.70	2±0	Oval	10.4±1.52	Singly, Pairs	21±4.85
35	FWJ44	White	-	8	19.2±3.96	2.5±0	3	6.2±1.09	2.2±0.27	Oval	14.8±5.76	Singly, Pairs	18.6±8.05
36	FWJ45	White	-	8	22.1±6.47	3±0.35	3	5.4±1.52	2.5±0.5	Oval	9.8±2.49	Singly, Pairs	19.2±5.26
37	FWJ46	White	Violet	8	16.4±4.34	2.6±0.42	3	6.4±1.14	2.7±0.45	Oval	10.4±2.70	Singly, Pairs	13.4±3.13
38	FWJ54	White	-	9	16.1±3.05	3.6±0.55	3	7.4±1.67	3.2±0.45	Oval	13±6.32	Singly, Pairs, S Chains	hort 16.4±4.39
39	FWJ55	White	Violet	9	17.6±2.70	3±0.35	3	6.6±0.89	2.3±0.45	Oval	8.2±2.05	Singly, Pairs, S Chains	hort 19.2±10.06
40	FWJ56	White	Violet	9	18.9±3.94	2.8±0.22	3	6.2±1.30	2.6±0.42	Oval	12.8±6.72	Singly, Pairs, S Chains	hort 20.2±9.86

44 PNX59 White 9 16+14 29+028 7.8+179 2.9+0.06 PNM 7.8+270 Ringth PM Short 28-8.4 43 PNX59 White 9 17.6+293 27+0.27 3 7.9-120 Singly PM Singly PM <td< th=""><th>41</th><th>FWJ57</th><th>White</th><th>Violet</th><th>9</th><th>17.2±4.87</th><th>2.9±0.22</th><th>3</th><th>7.2±1.92</th><th>2.7±0.57</th><th>Oval</th><th>11.2±1.79</th><th>Singly, Pairs, Short 14.6±8.05 Chains</th></td<>	41	FWJ57	White	Violet	9	17.2±4.87	2.9±0.22	3	7.2±1.92	2.7±0.57	Oval	11.2±1.79	Singly, Pairs, Short 14.6±8.05 Chains
B PW4.69 Wilde 9 J 244.03 2 240.27 3 7 26.12 2 464.05 Oval J 424.07 Single, PM3. Single, PM3. 44 PW4.60 White 9 16 \$	42	FWJ58	White	Violet	9	18±1.41	2.9±0.22	3	7.8±1.79	2.9±0.65	Oval	7.8±3.70	Singly, Pairs, Short 27.8±8.14 Chains
44 PWMod White 9 18.942.61 2780.27 3 5.66.019 2.446.42 Onal Install Singly PM 45 PWMod White - 9 20.842.68 2.840.27 1 6.842.10 2.440.65 Unit 9.442.64 Singly PM	43	FWJ59	White	-	9	17.6±4.93	2.7±0.27	3	7±2.12	2.6 ± 0.55	Oval	14.2±3.77	Singly, Pairs, Short 18±8.37 Chains
46 PM/Mri White 0 20.8+6.68 2.8+0.62 2.4+0.65 Oral 9.4+2.61 Signal Parks Numt 4.2+6.0.2 Chains 46 PM/Mar White - 8 15.8+3.44 6.6+0.32 3 6.7+1.45 2.6+0.65 Oral 6.2+2.11 Signal Parks Numt 4.2+6.0.2 47 PM/Mar White - 8 17.72.5.75 2.7.0.27 3 6.41.92 2.40.027 Oral 6.24.1.91 Signal Parks Numt 1.2+6.0.2 48 PM/Mar White - 8 16.54.1.1 2.50.0.2 Oral 10.84.1.9 Signal Parks Numt 1.2+6.0.2 49 PM/Mar White - 8 10.7.45.0.2 2.640.42 Oral 10.84.2.9 Signal Parks Numt 1.2+6.0.2 50 PM/Mar White - 8 10.44.5.9 2.640.42 Oral 10.42.2.9 Signal Parks Numt 1.2+6.2.2 51 PM/Mar White 10.44.5.9 2.640.42 Oral 10.44.2.9 Signal Parks Numt 1.2+64.2.6 51	44	FWJ60	White	-	9	18.9±2.61	2.7±0.27	3	5.6±0.89	2.4±0.42	Oval	10±2.45	Singly, Pairs, Short 19.4±6.99 Chains
de PWike Wike - 8 15/245,42 2.640.02 3 6.741.44 2.640.02 Oval R2.341.1 Simple Number of Calaxs 67 PW/50 Wike - 8 17.724.78 2.240.27 3 6.44.95 2.440.25 Oval 14.44 Simple Pitrs, Biont 35.4.7 64 PW/64 Wite - 8 16.674.44 2.940.27 3 5.474.32 2.940.42 Oval 0.852.40 Oval 0.852.40 Oval Oval Oval 0.842.43 Birly, Pitrs, Birls, Short 15.427.00 Oval 0.842.43 Birly, Pitrs, Birls, Short 15.427.00 Oval 0.843.78 Singly, Pitrs, Birls, Short 15.427.00 Oval 0.842.78 Singly, Pitrs, Birls, Birls, Fitrs, Birls, Fitrs, Birls, Fitrs, Birls, Fitrs, Birls, Fitrs, Birls, Birls, Fitrs, Birls, Fitrs, Birls, Fitrs, Birls, Birls, Fitrs, Birls, Birls, Fitrs, Birls, Birls, Fitrs,	45	FWJ61	White	-	9	20.8±2.68	2.8±0.27	3	6.6±2.30	2.4±0.65	Oval	9.4±2.61	Singly, Pairs, Short 14.2±6.02 Chains
97 PWL61 White - 8 17/24.57 2.724.57 3 6.44.19 2.440.55 Oral 14.44 Singly Patrix Short 35.47 68 PWL61 White - 8 165.44.11 2.400.27 Oral 9.84.2.19 Singly Patrix Short 15.2.4.15.00 60 PWL61 White - 8 167.4.6.92 2.850.42 3 5.742.22 2.850.42 Oral 164.8.4.38 Singly Patrix Short 15.2.4.15.00 60 PWL61 White - 8 19.446.19 2.756.0.2 3 6.441.52 2.850.42 Oral 10.452.35 Singly Patrix Short 15.4.2.0.2 52 PWL61 White 10 16.91.4.6 2.71.4.2 3 6.441.52 2.850.33 Oral 10.84.2.78 Singly Patrix Short 15.4.4.6.02 53 PWL61 White 8 10.91.4.6.2.30 2.81.0.03 6.21.1.02 0.84.1.6.2 Singly Patrix Short 15.4.4.6.2 54 PWL61 White Putrix White 10 16.91.4.5.2<	46	FWJ62	White	-	8	15.2±3.42	2.6±0.22	3	6.7±1.48	2.6±0.55	Oval	8.2±3.11	Singly, Pairs, Short 20.2±9.58 Chains
48 PW/04 White - 8 15,2±40 2,2±0.27 Oral 9,4±2,02 0,4±2,04 Other State of Chains 49 PW/05 White - 8 15,2±4,09 2,8±0,27 3 5,4±1,82 2,3±0,45 Oral 13,8±4,36 Chains 50 PW/05 White - 8 20,4±6,84 2,8±0,27 3 6,8±1,39 2,2±0,45 Oral 10,2±2,55 Singly, Pairs, Short 15,8±2,86 Chains 51 PW/05 White - 8 19,4±6,19 2,7±0,45 3 6,4±1,52 2,5±0,5 Oral 1,2±4,50 Chains 53 PW/05 White Violet 8 19,2±4,65 2,5±0,3 Oral 1,2±4,30 Singly, Pairs, Short 17,6±4,56 Chains 54 PW/07 White Dark Violet 9 16,4±3,22 2,5±0,5 Oral 1,2±4,313 Singly, Pairs, Short 17,6±4,56 Chains 57 PW03 White Dark Violet 9 1,6±1,32 <td>47</td> <td>FWJ63</td> <td>White</td> <td>-</td> <td>8</td> <td>17.7±5.78</td> <td>2.7±0.27</td> <td>3</td> <td>6.4±1.95</td> <td>2.4±0.55</td> <td>Oval</td> <td>14±4</td> <td>Singly, Pairs, Short 15±7 Chains</td>	47	FWJ63	White	-	8	17.7±5.78	2.7±0.27	3	6.4±1.95	2.4±0.55	Oval	14±4	Singly, Pairs, Short 15±7 Chains
49 FW165 White - 8 18.74.499 2.840.47 3 5.44.88 2.94.0.45 Vul 13.84.43.8 Decktor 50 FW166 White - 8 20.44.65 4 2.840.45 Vul 10.24.55 Singly, Pairs, Short 18.42.828 51 FW167 White - 8 19.446.19 2.75*0.43 3 6.841.30 2.440.42 Vul 13.6*2.37 Singly, Pairs, Short 18.42.622 52 FW168 White Violet 8 19.27.46 3 6.441.52 2.540.45 Orul 16.242.02 Singly, Pairs, Short 17.64.450 54 FW170 White - 8 19.27.43 2.640.47 Orul 10.842.95 Singly, Pairs, Short 17.64.450 54 FW170 White Dark Violet 9 10.242.83 2.840.42 Orul 14.64.273 Singly, Pairs, Short 17.64.450 57 FW03 White Dark Violet 9 10.242.83 2.740.27 Sinel.24 2.440.42	48	FWJ64	White	-	8	16.5±1.41	2.5±0	3	5.7±2.22	2.2±0.27	Oval	9.8±2.49	Singly, Pairs, Short 16.2±4.60 Chains
50 PW166 White - 8 20.4.6.4 2.8.40.4.5 Oral 10.2.8.5 Singly, Pairs, Bhort 18.2.8.86 Chains 51 PW167 White - 8 19.4.6.19 2.7.540.43 3 6.8.4.1.30 2.6.40.42 Oral 11.6.4.2.78 Singly, Pairs, Short 17.4.6.022 Chains 52 PW168 White Volet 8 19.7.44 2.7.20.45 3 6.4.4.1.52 2.540.05 Oral 11.2.8.2.9 Singly, Pairs, Short 14.4.6.022 Chains 53 PW160 White Volet 8 19.7.44 2.720.45 3 6.4.4.1.22 2.340.45 Oral 10.8.72.9 Singly, Pairs, Short 14.4.6.022 Chains 54 PW170 White Dark Volet 10 10.4.2.9 Singly, Pairs, Short 24.2.4.6.2 Oral 10.4.6.4.7.3 Singly, Pairs, Short 24.2.6.4.2.3 Oral 12.6.4.3.13 Singly, Pairs, Short 24.2.4.2.3 Oral 12.6.4.3.13 Singly, Pairs, Short 24.2.4.2.3 Oral 12.6.4.3.2 Singly, Pairs, Short 24.2.4.2.3 Singly, Pairs, Short 24.2.4.2.3 Singly, Pairs, Short 24.2.4.3<	49	FWJ65	White	-	8	18.7±4.99	2.8±0.27	3	5.4±1.82	2.3±0.45	Oval	13.8±4.38	Singly, Pairs, Short 15.4±7.60 Chains
31 FW367 White - 8 19,44.6.19 2.75±0.43 3 6.8+1.30 2.6±0.42 Oral 19,6±3.73 Singly, Pairs, Short 17,4±0.52 52 FW468 White Violet 8 22.4±0.43 3.0,4±0.41 3 6.4±1.52 2.5±0.35 Oral 11.2±2.39 Singly, Pairs, Short 17,6±4,66 Chains 53 FW469 White Violet 8 16.9±3.05 2.5±0.4 Oral 10.8±2.95 Singly, Pairs, Short 17,6±4,66 54 FW47 White Dirk Violet 10 16.2±0.03 2.8±0.45 Oral 14.0±2.73 Singly, Pairs, Short 2.6±4.31 56 FW43 White Dirk Violet 10 16.2±0.02 2.8±0.45 Oral 14.0±5.73 Singly, Pairs, Short 2.6±4.31 Singly, Pairs, Short 2.6±4.33 Singly, Pairs, Short 2.6±4.39 Singly, Pa	50	FWJ66	White	-	8	20.4±6.84	2.85±0.42	3	6.8±1.09	2.3±0.45	Oval	10 ± 2.55	Singly, Pairs, Short 18.2±2.86 Chains
Bay Box White Violet 8 22,46,23 2,94,0,43 6,44,152 2,540,35 Oral 11,28-230 Singly, Pairs, Short 14,4-6,52 Singly, Pairs White Violet 8 1947,48 2,740,45 3 6,441,52 2,340,45 Oral 8,824,95 Singly, Pairs, Short 15,64,56 Singly, Pairs White Dark Violet 10 16,242,00 2,540,5 Oral 10,842,95 Singly 21+102 Singly White Dark Violet 9 10,642,30 2,840,45 Oral 11,642,53 Singly 21+129 Singly White Dark Violet 9 10,642,34 Singly 21+129 2,840,45 Oral 18,642,08 Singly 21+129 2,840,45 Oral 18,642,08 Singly 21+129 2,840,45 Oral 18,642,08 Singly 21+129 2,840,45 Oral 18,642,04 Singly 20,842,35 Singly 20,842,35 Singly 20,842,35 Singly 21,842,40 Singly	51	FWJ67	White	-	8	19.4±6.19	2.75±0.43	3	6.8±1.30	2.6±0.42	Oval	13.6±3.78	Singly, Pairs, Short 17±4 Chains
53 FWJ69 White Violet 8 192748 2.720.42 3 6.421.52 2.320.45 Oval Shazaro Shazaro Chains 54 FWG1 White Dark Violet 10 45.242.03 2.540.5 Oval 10.842.95 Singly, Pairs, Short 12.64.34 55 FWG1 White Dark Violet 0 16.242.03 2.840.45 Oval 12.645.73 Singly, Pairs, Short 12.64.34 56 FWG2 White Dark Violet 0 20.342.77 3 5.840.84 2.440.42 Oval 12.643.43 Singly 13.842.49 58 FWG2 Pinksin Dark Violet 9 17.84.53 2.740.27 3 6.41.22 2.940.42 Oval 12.643.45 Singly 13.842.49 58 FWG3 White Dark Violet 9 17.84.25 2.540.23 5.841.44 2.940.22 Oval 13.264.05 Singly 14.84.24 3.842.45 3.842.45 3.842.45 3.842.45 3.842.45 </td <td>52</td> <td>FWJ68</td> <td>White</td> <td>Violet</td> <td>8</td> <td>22.4±6.23</td> <td>2.9±0.41</td> <td>3</td> <td>6.4±1.52</td> <td>2.5±0.35</td> <td>Oval</td> <td>11.2±2.39</td> <td>Singly, Pairs, Short 14.4±6.22 Chains</td>	52	FWJ68	White	Violet	8	22.4±6.23	2.9±0.41	3	6.4±1.52	2.5±0.35	Oval	11.2±2.39	Singly, Pairs, Short 14.4±6.22 Chains
54 FWJ70 White - 8 16.943.65 2.540.5 Oval 10.842.95 Sinely Pairs, Short 22.64.34 55 FWG1 White Dark Violet 9 16.442.61 2720.27 3 5.480.84 2.440.47 Ulat 4.645.73 Singly 9.481.36 56 FWG2 White Dark Violet 9 2.242.73 3.162.23 3.641.82 2.840.45 Oval 1.644.34 Singly 9.841.56 57 FWG3 White Violet 9 172.83 2.740.27 3 641.82 2.940.42 Oval 1.644.36 Singly 1.82.49 60 FWG6 White Violet 9 174.82.59 2.651.02 3 641.22 2.940.23 Oval 1.64.38 Singly 1.24.21.79 Singly 1.64.4.67 61 FWG9 White Violet 9 1.74.82.63 3 5.841.20 Oval 1.92.45.63 Singly 1.64.4.67 62 FWG	53	FWJ69	White	Violet	8	19±7.48	2.7±0.45	3	6.4±1.52	2.3±0.45	Oval	8.6±2.19	Singly, Pairs, Short 17.6±4.56 Chains
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	54	FWJ70	White	-	8	16.9±3.65	2.5±0	3	6.2±1.30	2.5±0.5	Oval	10.8±2.95	Singly, Pairs, Short 22.6±4.34 Chains
56 FWG2 White Dark Violet 9 16.4±2.61 27.9±2.7 3 5.8±0.84 2.4±0.42 Oval 12.6±3.13 Singly 2.9±3.68 57 FWG3 White Violet 9 17.8±83 2.7±0.27 3 6±1.87 2.8±0.45 Oval 16.8±0.408 Singly 11.8±2.49 58 FWG4 Pinkish Dark Violet 9 17.8±83 2.7±0.27 3 6±1.22 2.9±0.42 Oval 8.8±0.698 Singly 10.8±2.49.08 Singly 10.8±2.49.08 Singly 10.8±2.49.08 Singly 10.8±2.59 Singly 20.8±2.28 Singly 20.8±2.28 Singly 20.8±2.77 Singly 20.8±2.73 Singly 20.8±2.73 Singly 10.8±2.69 Singly 10.6±2.67 Singly 10.6±2.67 Singly 10.6±2.69 Singly 10.6±2.67 Singly 10.6±2.69 Singly 10.6±2.60 Singly 10.6±2.60 Singly 10.6±2.60 Singly 10.6±2.66 Singly 10.6±2.65 Singly 2.4±6.60 Singly 2.4±6.60 Singly 2.4±6.60 Singly <td< td=""><td>55</td><td>FWG1</td><td>White</td><td>Dark Violet</td><td>10</td><td>16.2±3.03</td><td>2.8±0.27</td><td>3</td><td>7.4±2.30</td><td>2.8±0.45</td><td>Oval</td><td>14.6±5.73</td><td>Singly 31±10.29</td></td<>	55	FWG1	White	Dark Violet	10	16.2±3.03	2.8±0.27	3	7.4±2.30	2.8±0.45	Oval	14.6±5.73	Singly 31±10.29
57 FWG3 While Violet 9 20,242,77 31±0.22 3 65±1.87 2.8±0.45 Oval 13,6±4.34 Singly 15,2±4.09 58 FWG4 Pinkish Dark Violet 9 17±2.83 2.7±0.27 3 6±1.22 2.6±0.42 Oval 8.6±0.89 Singly 11.8±2.49 59 FWG5 Pinkish Dark Violet 9 164.55 2.8±0.22 3 6±1.22 2.9±0.22 Oval 12.2±1.79 Singly 20.8±2.28 60 FWG6 White Violet 9 164.55 2.8±0.22 3 6±1.22 2.4±0.42 Oval 15.6±3.83 Singly 16.6±4.67 61 FWG7 White Violet 9 2.2±5.39 2.5±0.42 3 6±1.27 2.4±0.42 Oval 13.2±6.09 Singly 16.2±6.06 64 FWG10 White Dark Violet 10 2.6±5.42 3 6.2±1.07 2.5±0.5 Oval 14±2.48 Singly 2.4±6.66 65 FWG10 White Dark Violet 10 <td< td=""><td>56</td><td>FWG2</td><td>White</td><td>Dark Violet</td><td>9</td><td>16.4±2.61</td><td>2.7±0.27</td><td>3</td><td>5.8±0.84</td><td>2.4±0.42</td><td>Oval</td><td>12.6±3.13</td><td>Singly 29.8±13.68</td></td<>	56	FWG2	White	Dark Violet	9	16.4±2.61	2.7±0.27	3	5.8±0.84	2.4±0.42	Oval	12.6±3.13	Singly 29.8±13.68
58 FWG4 Pinkish Park Violet 9 17 ± 2.83 2.7 ± 0.27 3 6 ± 1.22 2.6 ± 0.42 Oval 8.6 ± 0.89 Singly 11.8 ± 2.49 59 FWG5 Pinkish Park Violet 9 20 ± 6.32 2.9 ± 0.42 3 6 ± 1.22 2.9 ± 0.42 $Oval$ 12.2 ± 1.79 Singly 20.8 ± 2.88 60 FWG6 White Dark Violet 9 17.8 ± 5.59 2.6 ± 0.25 3 6 ± 1.22 2.9 ± 0.32 $Oval$ 15.6 ± 3.85 Singly 21.2 ± 5.17 61 FWG7 White Dark Violet 9 17.8 ± 5.59 2.6 ± 0.25 3 6 ± 1.22 $Oval$ 7.8 ± 2.88 Singly 21.2 ± 6.17 63 FWG9 Pinkish Dark Violet 9 20.4 ± 5.18 31 ± 0.55 3 6.2 ± 1.30 2.8 ± 0.27 $Oval$ 10.4 ± 5.45 Singly 21.2 ± 6.46 64 FWG10 White Dark Violet 10 18.4 ± 7.37 2.8 ± 0.27 $Oval$ 14.4 ± 5.48 Singly 21.2 ± 6.46 65 FWG10 White	57	FWG3	White	Violet	9	20.3±2.77	3.1±0.22	3	6±1.87	2.8±0.45	Oval	13.6±4.34	Singly 15.2±4.09
59 FWG5 Pinkish White Dark Violet 9 20 ± 63.2 2.9 ± 0.42 3 6 ± 1.22 2.9 ± 0.22 Oval 12.2 ± 1.79 Singly 20.8 ± 2.28 60 FWG6 White Dark Violet 9 16 ± 2.55 2.5 ± 0.3 6 ± 1.32 2.5 ± 0.3 Oval 15.6 ± 3.85 Singly 20.8 ± 2.28 61 FWG7 White Violet 9 12.8 ± 5.99 2.65 ± 0.22 3 $8.42.28$ Singly 20.4 ± 2.517 62 FWG8 White Violet 9 2.3 ± 5.99 2.65 ± 0.22 3 $8.242.8$ Oval 7.8 ± 1.28 Singly $20.4\pm2.6.06$ 63 FWG1 White Dark Violet 9 2.4 ± 5.18 $3.\pm0.57$ 3 6.2 ± 1.30 2.8 ± 0.27 Oval 14 ± 5.48 Singly 21.2 ± 5.06 64 FWG1 White Dark Violet 10 26.4 ± 7.13 3.8 ± 0.27 3 6.2 ± 1.09 2.7 ± 0.45 Oval 14 ± 5.48 Singly $24\pm3.6.06$ 67 FWG18 White - 8	58	FWG4	Pinkish White	Dark Violet	9	17±2.83	2.7±0.27	3	6±1.22	2.6±0.42	Oval	8.6±0.89	Singly 11.8±2.49
60 FWG6 White Dark Violet 9 162.25 2.540 3 6.24.1.30 2.540.35 Oval 15.643.85 Singly 21.245.17 61 FWG7 White Violet 9 17.845.59 2.6540.23 5.840.34 2.540.35 Oval 7.641.52 Singly 20.647.99 62 FWG8 White Violet 9 2345.30 2.7540.25 3 6.81.22 2.440.42 Oval 19.424.60 Singly 10.624.67 63 FWG9 White Dark Violet 9 20.445.18 3.140.55 3 6.241.09 2.840.27 Oval 10.444.56 Singly 2.1246.46 64 FWG10 White Dark Violet 10 20.64.70.42 3 6.821.17 2.840.27 Oval 10.444.54 Singly 2.124.64 65 FWG13 White Dark Violet 10 20.64.24.13 3.621.02 2.440.42 Oval 19.643.21 Singly, Pairs, Short 16±5.05 Chains <td>59</td> <td>FWG5</td> <td>Pinkish White</td> <td>Dark Violet</td> <td>9</td> <td>20±6.32</td> <td>2.9±0.42</td> <td>3</td> <td>6±1.22</td> <td>2.9±0.22</td> <td>Oval</td> <td>12.2±1.79</td> <td>Singly 20.8±2.28</td>	59	FWG5	Pinkish White	Dark Violet	9	20±6.32	2.9±0.42	3	6±1.22	2.9±0.22	Oval	12.2±1.79	Singly 20.8±2.28
61 FWG7 White Violet 9 7.8±559 2.65±0.22 3 5.8±0.84 2.5±0.32 0val 7.6±152 Singly 20.6±7.99 62 FWG8 White Violet 9 23±539 2.75±0.25 3 6±1.22 2.4±0.42 Oval 9.8±2.28 Singly 16.6±4.67 63 FWG9 Pinkish Dark Violet 9 20.4±5.48 3.1±0.55 3 6.2±1.30 2.4±0.47 Oval 13.2±6.09 Singly 10.4±4.56 Singly 2.4±0.66 64 FWG10 White Dark Violet 10 8.4±7.47 2.8±0.47 0.4±0.07 Oval 10.4±4.56 Singly 2.4±0.46 65 FWG11 White Dark Violet 10 8.4±7.47 2.8±0.27 Oval 9.4±7.33 Singly 2.4±0.42 Oval 9.4±3.21 Singly 2.4±0.42 Oval 9.4±3.21 Singly, Pairs, Short 16±3.05 64 FWG14 White - 8 18.6±2.41 3.4±0.42 5.4±1.42 2.4±0.42 Oval 7.2±4.74 Singly, Pairs, Short 16±3.05	60	FWG6	White	Dark Violet	9	16±2.55	2.5±0	3	6.2±1.30	2.5 ± 0.5	Oval	15.6±3.85	Singly 21.2±5.17
62 FWG8 White Violet 9 23 ± 3.9 2.75 ± 0.25 3 6 ± 1.22 2.4 ± 0.42 Oval 9.8 ± 2.28 Singly 16.6 ± 4.67 63 FWG9 Pinkish Dark Violet 9 12.4 ± 0.1 2.5 ± 0.3 5 ± 1.30 340 Oval 12.2 ± 0.49 Singly 16.2 ± 6.06 64 FWG10 White Dark Violet 9 20.4 ± 5.18 3.1 ± 0.55 3 6.2 ± 1.30 2.8 ± 0.27 Oval 10.4 ± 4.56 Singly 24 ± 8.69 65 FWG10 White Dark Violet 10 20.4 ± 2.59 $2.96.4.2$ 6.8 ± 1.07 2.8 ± 0.27 $Oval$ 9.14 ± 5.43 Singly $21\pm 2.6.4.66$ 66 FWG13 White - 8 19.4 ± 3.13 3.8 ± 0.27 3 5.6 ± 1.07 2.4 ± 0.42 $Oval$ 9.1 ± 2.5 $Singly$ $Pairs, Short 16\pm 5.05$ 64 FWG14 White - 8 19.6 ± 0.02 3.5 ± 0.67 3 5.4 ± 0.25 2.5 ± 0 $Oval$ 11.2 ± 2.78 $Singly$ $Pairs, Short 16\pm 5.05$	61	FWG7	White	Violet	9	17.8±5.59	2.65±0.22	3	5.8±0.84	2.5 ± 0.35	Oval	7.6±1.52	Singly 20.6±7.99
63 FWG9 Pinkish Write Dark Violet 9 14.4±2.61 2.5±0 3 5.8±1.30 3±0 Oval 13.2±6.09 Singly 16.2±6.06 64 FWG10 White Dark Violet 9 20.4±5.18 3.1±0.55 3 6.2±1.30 2.8±0.27 Oval 10.4±4.56 Singly 24±8.69 65 FWG11 White Dark Violet 10 18.4±7.27 2.8±0.42 3 6.8±1.09 2.7±0.45 Oval 9.4±3.3 Singly 24±7.38 67 FWG13 White - 8 19.4±3.13 3.8±0.27 3 5.6±1.07 2.4±0.42 Oval 9.6±3.21 Singly, Pairs, Short 12.2±2.28 64 FWG14 White - 8 18.6±2.41 3.4±0.42 3 5.8±1.48 2.2±0.27 Oval 11.2±2.78 Singly, Pairs, Short 16±5.05 Chains 69 FWG15 White - 8 19.6±6.02 3.5±0.67 3 5.4±0.22 Oval 11.8±6.02 Singly, Pairs, Short 16±5.05 Chains 70 FWG16 White -<	62	FWG8	White	Violet	9	23±5.39	2.75±0.25	3	6±1.22	2.4±0.42	Oval	9.8±2.28	Singly 16.6±4.67
64 FWG10 White Dark Violet 9 20.4 ± 5.18 3.1 ± 0.55 3 6.2 ± 1.30 2.8 ± 0.27 Oval 10.4 ± 4.56 Singly 24 ± 8.69 65 FWG11 White Dark Violet 10 10.8 ± 7.7 2.8 ± 0.42 3 6.8 ± 1.7 2.5 ± 0.5 Oval 14 ± 5.48 Singly 2.2 ± 2.646 66 FWG12 White Dark Violet 10 20.6 ± 5.98 2.9 ± 0.42 3 6.2 ± 1.09 2.7 ± 0.45 $Oval$ 9 ± 1.73 Singly 24 ± 7.38 67 FWG13 White - 8 19.4 ± 3.13 3.8 ± 0.27 3 5.8 ± 1.48 2.2 ± 0.27 $Oval$ 9 ± 1.73 Singly, Pairs, Short $16\pm2.5\pm0.5$ 68 FWG14 White - 8 19.6 ± 6.02 3.5 ± 1.48 2.2 ± 0.27 $Oval$ 7 ± 1.41 Singly, Pairs, Short 16 ± 3.96 64.41 2.4 ± 0.22 $Oval$ 11.8 ± 0.2 $Singly, Pairs, Short 15\pm2.5 Chains 70 FWG16 White - 9 18.8\pm4.76 3.7\pm0.67 5.5\pm1.02 $	63	FWG9	Pinkish White	Dark Violet	9	14.4±2.61	2.5±0	3	5.8±1.30	3±0	Oval	13.2±6.09	Singly 16.2±6.06
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	64	FWG10	White	Dark Violet	9	20.4±5.18	3.1±0.55	3	6.2±1.30	2.8±0.27	Oval	10.4±4.56	Singly 24±8.69
66 FWG12 White Dark Violet 10 20.6 ± 5.98 2.92-0.42 3 6.2±1.09 2.7±0.45 Oval 9±1.73 Singly 24±7.38 67 FWG13 White - 8 19.4±3.13 3.8±0.27 3 5.6±2.07 2.4±0.42 Oval 9.6±3.21 Singly, Pairs, Short 12.2±2.28 68 FWG14 White - 8 18.6±2.41 3.4±0.42 3 5.8±1.48 2.2±0.27 Oval 9.6±3.21 Singly, Pairs, Short 16.±5.05 69 FWG15 White - 8 19.6±6.02 3.5±0.61 3 6±1.41 2.6±0.22 Oval 7±1.41 Singly, Pairs, Short 14.4±4.34 70 FWG16 White - 9 20±4.47 3.4±0.42 3 5±1 2.4±0.22 Oval 11.8±6.02 Singly, Pairs, Short 16.±4.69 71 FWG17 White - 9 18.8±4.76 3.7±0.67 3 5.4±0.55 2.5±0 Oval 10.2±2.68 Singly, Pairs, Short 16.±4.69 72 FWG18 White - 8 19±4.36 <th< td=""><td>65</td><td>FWG11</td><td>White</td><td>Dark Violet</td><td>10</td><td>18.4±7.27</td><td>2.85±0.42</td><td>3</td><td>6.8±2.17</td><td>2.5±0.5</td><td>Oval</td><td>14±5.48</td><td>Singly 21.2±6.46</td></th<>	65	FWG11	White	Dark Violet	10	18.4±7.27	2.85±0.42	3	6.8±2.17	2.5±0.5	Oval	14±5.48	Singly 21.2±6.46
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	66	FWG12	White	Dark Violet	10	20.6+5.08	2.0+0.42	2	6.2+1.00	2.7±0.45	Oval	0+1.72	Singly 24+7.28
07 FWG13 Wilte $ 8$ $19,4\pm3,13$ $3,0\pm2,07$ $24\pm0,42$ 074 $9,0\pm3,17$ $3,0\pm2,07$ 68 FWG14 White $ 8$ $18,6\pm2,41$ $3,4\pm0,42$ 3 $5,8\pm1,48$ 2.2 ± 0.27 $07al$ 11.2 ± 2.78 $Singly, Pairs, Short 16.25,05$ 69 FWG15 White $ 8$ $19,6\pm6.02$ 3.5 ± 0.61 3 6 ± 1.41 2.6 ± 0.22 $07al$ 11.2 ± 2.78 $Singly, Pairs, Short 16.4±4.33$ 70 FWG16 White $ 9$ 20 ± 4.47 3.4 ± 0.42 3 5 ± 1 2.4 ± 0.22 $0ral$ 11.8 ± 6.02 $Singly, Pairs, Short 14.4\pm4.34$ 71 FWG17 White $ 9$ 18.8 ± 4.76 3.7 ± 0.67 3 5.4 ± 0.55 2.5 ± 0 $0ral$ 10.2 ± 2.68 $Singly, Pairs, Short 16.2\pm3.69$ 72 FWG18 White $ 8$ 19.2 ± 3.35 3 ± 0.35 3 5.6 ± 1.52 2.3 ± 0.27 $0ral$ 11.6 ± 2.70 $Singly, Pairs, Short 15.2\pm7$ 73 FWG19 White	67	FWC10	White	Dark violet	0	20.0±5.90	2.9±0.42	3	5.610.07	2./±0.45	Oval	9±1./3	Singly Doirs Short 10.0.0.0
68 FWG14 White - 8 18.9±2.41 3.4±0.42 3 5.8±1.48 2.2±0.27 Oval 11.2±2.78 Singly, Pairs, Short 10±5.05 69 FWG15 White - 8 19.6±6.02 3.5±0.61 3 6±1.41 2.6±0.22 Oval 7±1.41 Singly, Pairs, Short 10±5.05 70 FWG16 White - 9 20±4.47 3.4±0.42 3 5±1 2.4±0.22 Oval 7±1.41 Singly, Pairs, Short 12.4±4.34 71 FWG17 White - 9 18.8±4.76 3.7±0.67 3 5.4±0.55 2.5±0 Oval 10.2±2.68 Singly, Pairs, Short 12.2±3.63 72 FWG18 White - 8 19.2±3.35 3±0.35 3 5.6±1.52 2.3±0.27 Oval 11.6±2.70 Singly, Pairs, Short 15±7 73 FWG19 White - 8 19.4±3.65 3.4±0.65 3 6.8±1.41 2.5±0.35 Oval 15.2±5.02 Singly, Pairs, Short 13.6±4.33 74 FWG20 White - 9 19.4±3.63 3.1±0.82	67	FWG13	white	-	0	19.4±3.13	3.8±0.27	3	5.0±2.07	2.4±0.42	Oval	9.0±3.21	Chains
69 FWG15 White - 8 19.646.02 3.540.01 3 6±1.41 2.6±0.22 Oval 7±1.41 Singly, Pairs, Short 14.4±4.34 70 FWG16 White - 9 20±4.47 3.4±0.42 3 5±1 2.4±0.22 Oval 11.8±6.02 Singly, Pairs, Short 12.2±3.63 71 FWG17 White - 9 18.8±4.76 3.7±0.67 3 5.4±0.55 2.5±0 Oval 10.2±2.68 Singly, Pairs, Short 16±4.69 72 FWG18 White - 8 19.2±3.35 3±0.35 3 5.6±1.52 2.3±0.27 Oval 11.6±2.70 Singly, Pairs, Short 15±7 73 FWG19 White - 8 19.4±3.6 3.4±0.65 3 6.8±1.64 2.5±0.35 Oval 16.2±7.02 Singly, Pairs, Short 13.6±4.39 74 FWG20 White - 9 19.08±5.5 3.3±0.57 3 5.6±1.14 2.5±0.36 Oval 15.2±5.02 Singly, Pairs, Short 13.6±3.39 75 FWG21 White - 8 17.4±6.31 3.1±0.82	68	FWGI4	white	-	8	18.0±2.41	3.4±0.42	3	5.8±1.48	2.2±0.27	Oval	11.2±2.78	Chains
70 FWG16 Wnite - 9 20 ± 4.47 3.4 ± 0.42 3 5 ± 1 2.4 ± 0.22 Oval 11.8 ± 0.02 Singly, Pars, Short 12.2 ± 3.63 Chains 71 FWG17 White - 9 18.8 ± 4.76 3.7 ± 0.67 3 5.4 ± 0.55 2.5 ± 0 Oval 10.2 ± 2.68 Singly, Pars, Short 16 ± 4.69 Chains 72 FWG18 White - 8 19.2 ± 3.35 3 ± 0.35 3 5.6 ± 1.52 2.3 ± 0.27 Oval 11.6 ± 2.70 Singly, Pairs, Short 16 ± 4.69 Chains 73 FWG19 White - 8 19 ± 4.36 3.4 ± 0.65 3 6.8 ± 1.64 2.5 ± 0.35 Oval 8.8 ± 1.79 Singly, Pairs, Short 11.6 ± 3.85 Chains 74 FWG20 White - 9 19.08 ± 5.5 3.3 ± 0.57 3 6.4 ± 1.14 2.8 ± 0.27 Oval 10 ± 1.41 Singly, Pairs, Short 13.6 ± 4.33 Chains 75 FWG21 White - 8 17.4 ± 6.31 3.1 ± 0.82 3 6.4 ± 1.14 2.8 ± 0.27 Oval 10 ± 1.41 Singly, Pairs, Short 13.6 ± 4.33 Chains	69	FWG15	white	-	8	19.6±6.02	3.5±0.61	3	6±1.41	2.6±0.22	Oval	7±1.41	Chains
71 FWG17 White - 9 18.8 ± 4.76 3.7 ± 0.67 3 5.4 ± 0.55 2.5 ± 0 Oval 10.2 ± 2.68 Singly, Pairs, Short 16 ± 4.69 Chains 72 FWG18 White - 8 19.2 ± 3.35 3 ± 0.35 3 5.6 ± 1.52 2.3 ± 0.27 Oval 11.6 ± 2.70 Singly, Pairs, Short 15 ± 7 Chains 73 FWG19 White - 8 19 ± 4.36 3.4 ± 0.65 3 6.8 ± 1.64 2.5 ± 0.35 Oval 8.8 ± 1.79 Singly, Pairs, Short 13.6 ± 3.85 Chains 74 FWG20 White - 9 19.08 ± 5.5 3.3 ± 0.57 3 5.6 ± 1.14 2.5 ± 0.35 Oval 15.2 ± 5.02 Singly, Pairs, Short 13.6 ± 4.33 Chains 75 FWG21 White - 8 17.4 ± 6.31 3.1 ± 0.82 3 6.4 ± 1.14 2.8 ± 0.27 Oval 10 ± 1.41 Singly, Pairs, Short 18.6 ± 3.29 Chains 76 FWG22 White - 7 20 ± 6.32 3.2 ± 0.57 3 5.4 ± 0.55 2.5 ± 0 Oval 11.2 ± 1.79 </td <td>70</td> <td>FWG16</td> <td>White</td> <td>-</td> <td>9</td> <td>20±4.47</td> <td>3.4±0.42</td> <td>3</td> <td>5±1</td> <td>2.4±0.22</td> <td>Oval</td> <td>11.8±6.02</td> <td>Singly, Pairs, Short 12.2±3.63 Chains</td>	70	FWG16	White	-	9	20±4.47	3.4±0.42	3	5±1	2.4±0.22	Oval	11.8±6.02	Singly, Pairs, Short 12.2±3.63 Chains
72 FWG18 White - 8 19.2 ± 3.35 3 ± 0.35 3 5.6 ± 1.52 2.3 ± 0.27 Oval 11.6 ± 2.70 Singly, Pairs, Short 15 ± 7 Chains 73 FWG19 White - 8 19.2 ± 3.35 3 ± 0.35 3 5.6 ± 1.52 2.3 ± 0.27 Oval 11.6 ± 2.70 Singly, Pairs, Short 15 ± 7 Chains 73 FWG19 White - 8 19 ± 4.36 3.4 ± 0.65 3 6.8 ± 1.64 2.5 ± 0.35 Oval 8.8 ± 1.79 Singly, Pairs, Short 11.6 ± 3.85 Chains 74 FWG20 White - 9 19.08 ± 5.5 3.3 ± 0.57 3 5.6 ± 1.14 2.5 ± 0.36 Oval 15.2 ± 5.02 Singly, Pairs, Short 13.6 ± 4.33 Chains 75 FWG21 White - 8 17.4 ± 6.31 3.1 ± 0.82 3 6.4 ± 1.14 2.8 ± 0.27 Oval 10 ± 1.41 Singly, Pairs, Short 13.6 ± 4.329 Chains 76 FWG22 White - 7 20 ± 6.32 3.2 ± 0.57 3 6.2 ± 1.30 2.55 ± 0.37 Oval 11.2 ± 1.79 Singly, Pairs, Short 13.4 ± 5.64 Chains	71	FWG17	White	-	9	18.8±4.76	3.7±0.67	3	5.4±0.55	2.5±0	Oval	10.2±2.68	Singly, Pairs, Short 16±4.69 Chains
73 FWG19 White - 8 19 ± 4.36 3.4 ± 0.65 3 6.8 ± 1.64 2.5 ± 0.35 Oval 8.8 ± 1.79 Singly, Pairs, Short 11.6 ±3.85 74 FWG20 White - 9 19.08 ± 5.5 3.3 ± 0.57 3 5.6 ± 1.14 2.5 ± 0.36 Oval 15.2 ± 5.02 Singly, Pairs, Short 13.6 ±4.33 75 FWG21 White - 8 17.4 ± 6.31 3.1 ± 0.82 3 6.4 ± 1.14 2.8 ± 0.27 Oval 10 ± 1.41 Singly, Pairs, Short 13.6 ±4.33 76 FWG22 White - 7 20 ± 6.32 3.2 ± 0.57 3 6.2 ± 1.30 2.55 ± 0.37 Oval 10 ± 1.41 Singly, Pairs, Short 13.6 ±3.29 76 FWG23 White - 7 20 ± 6.32 3.2 ± 0.57 3 6.2 ± 1.30 2.55 ± 0.37 Oval 11.2 ± 1.79 Singly, Pairs, Short 13.4 ±5.64 77 FWG23 White - 8 17.6 ± 3.91 3 ± 0.61 3 5.4 ± 0.55 2.5 ± 0 Oval 14.2 ± 5.12 Singly, Pairs, Short 19.2 ±1.30 78 FWG24 White <td>72</td> <td>FWG18</td> <td>White</td> <td>-</td> <td>8</td> <td>19.2±3.35</td> <td>3±0.35</td> <td>3</td> <td>5.6±1.52</td> <td>2.3±0.27</td> <td>Oval</td> <td>11.6±2.70</td> <td>Singly, Pairs, Short 15±7 Chains</td>	72	FWG18	White	-	8	19.2±3.35	3±0.35	3	5.6±1.52	2.3±0.27	Oval	11.6±2.70	Singly, Pairs, Short 15±7 Chains
74 FWG20 White - 9 19.08±5.5 3.3 ± 0.57 3 5.6 ± 1.14 2.5 ± 0.36 Oval 15.2 ± 5.02 Singly, Pairs, Short 13.6±4.33 75 FWG21 White - 8 17.4 ± 6.31 3.1 ± 0.82 3 6.4 ± 1.14 2.8 ± 0.27 Oval 10 ± 1.41 Singly, Pairs, Short 13.6±4.33 76 FWG22 White - 7 20 ± 6.32 3.2 ± 0.57 3 6.2 ± 1.30 2.55 ± 0.37 Oval 10 ± 1.41 Singly, Pairs, Short 13.4±5.64 76 FWG23 White - 7 20 ± 6.32 3.2 ± 0.57 3 6.2 ± 1.30 2.55 ± 0.37 Oval 11.2 ± 1.79 Singly, Pairs, Short 13.4±5.64 77 FWG23 White - 8 17.6 ± 3.91 3 ± 0.61 3 5.4 ± 0.55 2.5 ± 0 Oval 14.2 ± 5.12 Singly, Pairs, Short 19.2±1.30 78 FWG24 White - 9 19.4 ± 4.88 3.2 ± 0.57 3 5.6 ± 1.14 2.7 ± 0.27 Oval 9.4 ± 0.89 Singly, Pairs, Short 18.8\pm4.60 79 FWG25 White	73	FWG19	White	-	8	19±4.36	3.4±0.65	3	6.8±1.64	2.5±0.35	Oval	8.8±1.79	Singly, Pairs, Short 11.6±3.85 Chains
75 FWG21 White - 8 17.4±6.31 3.1±0.82 3 6.4±1.14 2.8±0.27 Oval 10±1.41 Singly, Pairs, Short 18.6±3.29 Chains 76 FWG22 White - 7 20±6.32 3.2±0.57 3 6.2±1.30 2.55±0.37 Oval 11.2±1.79 Singly, Pairs, Short 13.4±5.64 Chains 77 FWG23 White - 8 17.6±3.91 3±0.61 3 5.4±0.55 2.5±0 Oval 14.2±5.12 Singly, Pairs, Short 19.2±1.30 Chains 78 FWG24 White - 9 19.4±4.88 3.2±0.57 3 5.6±1.14 2.7±0.27 Oval 9.4±0.89 Singly, Pairs, Short 18.8±4.60 Chains 79 FWG25 White - 9 17.6±3.58 2.8±0.45 3 6±1.22 2.6±0.42 Oval 8.8±3.56 Singly, Pairs, Short 14.6±6.07 Chains	74	FWG20	White	-	9	19.08±5.5 5	3.3±0.57	3	5.6±1.14	2.5±0.36	Oval	15.2±5.02	Singly, Pairs, Short 13.6±4.33 Chains
76 FWG22 White - 7 20±6.32 3.2±0.57 3 6.2±1.30 2.55±0.37 Oval 11.2±1.79 Singly, Pairs, Short 13.4±5.64 Chains 77 FWG23 White - 8 17.6±3.91 3±0.61 3 5.4±0.55 2.5±0 Oval 14.2±5.12 Singly, Pairs, Short 19.2±1.30 Chains 78 FWG24 White - 9 19.4±4.88 3.2±0.57 3 5.6±1.14 2.7±0.27 Oval 9.4±0.89 Singly, Pairs, Short 18.8±4.60 Chains 79 FWG25 White - 9 17.6±3.58 2.8±0.45 3 6±1.22 2.6±0.42 Oval 8.8±3.56 Singly, Pairs, Short 14.6±6.07 Chains	75	FWG21	White	-	8	17.4±6.31	3.1±0.82	3	6.4±1.14	2.8±0.27	Oval	10±1.41	Singly, Pairs, Short 18.6±3.29 Chains
77 FWG23 White - 8 17.6±3.91 3±0.61 3 5.4±0.55 2.5±0 Oval 14.2±5.12 Singly, Pairs, Short 19.2±1.30 78 FWG24 White - 9 19.4±4.88 3.2±0.57 3 5.6±1.14 2.7±0.27 Oval 9.4±0.89 Singly, Pairs, Short 18.8±4.60 79 FWG25 White - 9 17.6±3.58 2.8±0.45 3 6±1.22 2.6±0.42 Oval 8.8±3.56 Singly, Pairs, Short 14.6±6.07 79 FWG25 White - 9 17.6±3.58 2.8±0.45 3 6±1.22 2.6±0.42 Oval 8.8±3.56 Singly, Pairs, Short 14.6±6.07 Chains - - 9 17.6±3.58 2.8±0.45 3 6±1.22 2.6±0.42 Oval 8.8±3.56 Singly, Pairs, Short 14.6±6.07	76	FWG22	White	-	7	20±6.32	3.2±0.57	3	6.2±1.30	2.55±0.37	Oval	11.2±1.79	Singly, Pairs, Short 13.4±5.64 Chains
78 FWG24 White - 9 19.4±4.88 3.2±0.57 3 5.6±1.14 2.7±0.27 Oval 9.4±0.89 Singly, Pairs, Short 18.8±4.60 79 FWG25 White - 9 17.6±3.58 2.8±0.45 3 6±1.22 2.6±0.42 Oval 8.8±3.56 Singly, Pairs, Short 14.6±6.07 Chains	77	FWG23	White	-	8	17.6±3.91	3±0.61	3	5.4±0.55	2.5±0	Oval	14.2±5.12	Singly, Pairs, Short 19.2±1.30 Chains
79 FWG25 White 9 17.6±3.58 2.8±0.45 3 6±1.22 2.6±0.42 Oval 8.8±3.56 Singly, Pairs, Short 14.6±6.07 Chains	78	FWG24	White	-	9	19.4±4.88	3.2±0.57	3	5.6±1.14	2.7±0.27	Oval	9.4±0.89	Singly, Pairs, Short 18.8±4.60 Chains
	79	FWG25	White	-	9	17.6±3.58	2.8±0.45	3	6±1.22	2.6±0.42	Oval	8.8±3.56	Singly, Pairs, Short 14.6±6.07 Chains

80	FWG26	White	-	8	19.4±6.69	3.1±0.82	3	5.4±1.52	2.55±0.37	Oval	13±4.12	Singly, Pairs, Short 15±5.43 Chains
81	FWS1	White	-	9	20.6±5.08	2.9±0.22	3	8±1.58	2.9±0.22	Oval	9.4±1.14	Singly, Pairs, Short 12.2±4.38 Chains
82	FWS2	White	-	9	18.2±4.82	2.5±0	3	4.8±0.91	2.5±0	Oval	12±0.71	Singly, Pairs, Short 15±6.59 Chains
83	FWS3	White	-	9	19.2±8.44	2.7±0.27	3	5.2±0.45	2.5±0	Oval	8.4±1.67	Singly, Pairs, Short 12±4.64 Chains
84	FWS4	White	-	9	15.2±6.30	2.6±0.22	3	6.2±1.30	2.6±0.42	Oval	8.6±0.89	Singly, Pairs, Short 22±8 Chains
85	FWS5	White	-	9	18.7±1.20	2.5±0	3	5.3±0.67	2.5±0	Oval	14±5.70	Singly, Pairs, Short 21.2±5.40 Chains
86	FWS6	White	-	9	17.2±3.27	2.5±0	3	4.8±0.91	2.4±0.22	Oval	7.6±1.82	Singly, Pairs, Short 17.4±12.24 Chains
87	FWS7	White	-	9	18.8±5.22	2.6±0.22	3	6.4±0.55	2.7±0.27	Oval	9.8±3.19	Singly, Pairs, Short 13.6±2.61 Chains
88	FWS8	White	-	9	18.5±3.04	2.55±0.11	3	4.8±0.84	2.45±0.27	Oval	8.6±0.89	Singly, Pairs, Short 10.6±3.29 Chains
89	FWS9	White	-	9	21±3.46	2.6±0.22	3	6±1.73	2.6±0.22	Oval	9.2±1.30	Singly, Pairs, Short 17.2±4.87 Chains
90	FWS10	White	-	9	16±4.85	2.5±0	3	5.2±0.84	2.5±0	Oval	13±4.47	Singly, Pairs, Short 8.1±1.95 Chains
91	FWL5	White	Dark Violet	11	10.2±1.44	2.2±0.27	3	4±0.94	1.75±0.5	Oval	9.2±0.45	Singly, Short Chains 11.9±5.44
92	FWL6	White	Dark Violet	8	8±1.17	2.5±0.35	3	5±0	2.4±0.22	Oval	7±1	Singly, Pairs, Short 10.2±6.87 Chains
93	FWL7	Pinkish White	-	8	16.2±3.63	3±0	3	5.8±1.09	2.1±0.22	Oval	10.6±3.13	Singly, Pairs, Short 9.6±3.51 Chains
94	FWL8	Pinkish White	-	11	10±1.06	2±0.35	3	4±0	1.75±0	Oval	8.8±0.84	Singly, Pairs, Short 15.4±9.53 Chains
95	FWL9	Pinkish White	-	11	10±1.66	2.2±0.31	3	4±0.94	1.75±0.5	Oval	8.8±0.84	Singly 11.6±6.73
96	FWL10	White	-	11	19±5.39	3±0.35	3	6±1.87	2±0	Oval	7.8±1.48	Singly 10.6±6.99
97	FWL12	White	-	8	13±2.98	2.4±0.42	3-4	4.2±0.84	1.95±0.45	Oval	9±0.71	Singly 15.6±8.56
98	FWL13	White	Violet	8	13.4±1.95	3±0	3-4	5.4±0.55	2.8 ± 0.27	Oval	10.2 ± 1.30	Singly 10±3.54
99	FWL14	White	Violet	8	14±1.87	2.9 ± 0.22	3-4	5.6±0.89	2.9 ± 0.22	Oval	10.6±1.67	Singly 15±5.19
100	FWL15	White	Violet	8	16.8±3.63	3±0	3-4	5.4 ± 0.55	2.7 ± 0.27	Oval	11.4±0.89	Singly 16.2±5.67
101	FWL16	White	Violet	8	17±2	3±0.35	3-4	6±1	2.8 ± 0.27	Oval	9.6±0.89	Singly 16.1±6.43
102	FWB10	White	Dark Violet	10	19±2.65	3±0	3	6.6±0.89	2.9±0.42	Oval	8.8±1.09	Singly 14.2±7.53
103	FWK1	White	Dark Violet	8	18.8±4.55	2.6±0.22	3	5.8±1.30	2.5±0	Oval	12±5.48	Singly, Pairs, Short 16.2±6.09 Chains
104	FWK2	White	Dark Violet	8	19.7±1.30	2.55±0.11	3	6±1	2.5±0.5	Oval	13.8±3.03	Singly, Pairs, Short 18.6±2.71 Chains
105	FWK3	White	Dark Violet	8	15.8±3.63	2.6±0.22	3	6.4±0.89	2.4±0.42	Oval	14±5.15	Singly, Pairs, Short 12.6±3.97 Chains

Data based on mean of five readings per morphological character, $\pm =$ Standard deviation, - = Absence, D= Days to fill 9 cm plate, S= Septation.

The cells at the end of macro-conidia serves an important identification character of *Fusarium* species and pointed apical and foot-shaped basal cell were observed among the isolates (Toussoun and Nelson, 1976; Nelson *et al.*, 1983; Leslie and Summerell, 2006). Single-celled oval micro-conidia were noted and in some (5 isolates; 4.77%) viz. FWC5, FWC11, FWJ1, FWJ2 and FWJ3, 2-celled oval conidia produced in false heads were also seen (Burgess *et al.*, 1989). Micro-conidia size ranged from 4.0 ± 0.94 (FWL5, FWL8 and FWL9) to 8.8 ± 1.30 µm (FWC10) in length and 1.75 ± 0.5 (FWL5, FWL8 and FWL9) to 3.2 ± 0.45 µm (FWJ54) in width. Conidiogenous cells were found short and plump monophialides. This

unique character observed in the study helped differentiating *F. oxysporum* from other species such as, *F. solani* with long and slender monophialides (Seifert, 2001), *F. commune* with long monophialides and polyphialides (Skovgaard *et al.*, 2003).

Smooth and rough-walled chlamydospores formed singly, in pairs and short chains were seen in 3-4 weeks old cultures (Leslie and Summerell, 2006). These were either produced terminally or intercalary. The diameter of chlamydospores ranged from 7.0 \pm 1.41 (FWC16, FWG15 and FWL6) to 15.6 \pm 3.85 µm (FWG6).

The isolates showed variations in most of the morphological characters studied such as pigmentation, days to fill 9 cm plate, microscopic measurements including micro-conidia, macroconidia, chlamydospore, interseptal distance and therefore grouped accordingly. Of the 105 isolates characterized morphologically, 31 isolates were selected as type isolates for molecular analysis and pathogenicity testing.

Table 3. Mean wilt severity index, incidence and yield reduction caused by *Fusarium oxysporum* f. sp. *lentis* isolates on lentils.

No.	Isolate ID	GenBank	District	of NARC-08-1				Masoor-93			
		Accession No.	Origin								
				Disease Severity*	Disease	Yield	DR	Disease Severity*	Disease Incidence	Yield Reduction	DR
				(%)	Incidence (%)	Reduction		(%)	(%)	(%)	
1	FWC5	KR139797	Chakwal	53.3 ^f	100 a	51.71 °	М	3.7 ^j	26.67 ^{cd}	26.81 ^{ghij}	L
2	FWC6	KR139798	Chakwal	54.81 ^f	100 ^a	47.69 ^{cd}	М	11.11 ⁱ	100 ^a	26.31 hij	L
3	FWC8	KR139799	Chakwal	55.55 ^{ef}	100 ^a	47.26 ^{cd}	М	0 ^k	0 f	6.47 ¹	А
4	FWC10	KR139800	Chakwal	0 ^h	0 ^b	19.33 ^f	Α	0 ^k	0 ^f	21.62 ^{ijk}	Α
5	FWC11	KR139801	Chakwal	60 ^d	100 ^a	42.62 de	М	1.48 ^{jk}	13.33 ^e	34.67 ^{efg}	L
6	FWC15	KR139802	Chakwal	88.14 ^b	100 ^a	100 ^a	Н	65.92 ^{ab}	100 ^a	47.12 ^{ab}	М
7	FWC21	KR139803	Chakwal	45.18 ^g	100 ^a	37.66 ^e	Μ	0 ^k	0 f	19.88 ^{jk}	Α
8	FWC22	KR139804	Chakwal	54.07 ^f	100 ^a	49.90 ^{cd}	М	57.03 ^c	86.7 ^b	39.63 bcde	М
9	FWJ2	KR139805	Jhelum	60 ^d	100 ^a	48.63 ^{cd}	М	16.29 ^h	100 ^a	36.68 def	L
10	FWJ4	KR139806	Jhelum	63.7 °	100 ^a	52.95 °	Μ	65.92 ^{ab}	100 ^a	37.97 ^{cdef}	М
11	FWJ8	KR139807	Jhelum	64.44 ^c	100 ^a	49.12 ^{cd}	М	45.92 ^{fg}	100 ^a	40.56 ^{bcde}	М
12	FWJ11	KR139808	Jhelum	66.66 ^c	100 ^a	45.21 ^{cde}	Μ	0 ^k	0 ^f	22.86 hijk	Α
13	FWJ14	KR139809	Jhelum	45.18 ^g	100 ^a	41.61 ^{de}	Μ	48.14 ^{ef}	100 ^a	47.00 ^{ab}	М
14	FWJ15	KR139810	Jhelum	45.92 ^g	100 ^a	49.09 ^{cd}	М	0 ^k	0 ^f	23.64 ^{hijk}	Α
15	FWJ16	KR139811	Jhelum	58.51^{de}	100 ^a	49.67 ^{cd}	Μ	0 ^k	0 ^f	27.70 ^{ghij}	А
16	FWJ35	KR139812	Jhelum	100 ^a	100 ^a	100 ^a	Η	49.63 ^e	100 ^a	46.51 ^{ab}	М
17	FWG1	KR139813	Gujrat	89.62 ^b	100 ^a	100 ^a	Η	57•77 ^c	100 ^a	46.87 ^{ab}	М
18	FWG13	KR139814	Gujrat	46.66 ^g	100 ^a	49.07 ^{cd}	М	12.59 ⁱ	33.33 °	30.15 ^{fgh}	L
19	FWS1	KR139815	Sialkot	44.44 ^g	100 ^a	48.23 ^{cd}	М	2.22 ^{jk}	20 ^{de}	28.11 ^{ghi}	L
20	FWS3	KR139816	Sialkot	66.66 ^c	100 ^a	66.32 ^b	М	2.22 ^{jk}	20 ^{de}	25.66 hij	L
21	FWS5	KR139817	Sialkot	53.33 ^f	100 ^a	52.93 ^c	М	48.89 ^e	86.7 ^b	45.09 ^{bc}	М
22	FWS7	KR139818	Sialkot	66.66 ^c	100 ^a	42.65 ^{de}	М	44 . 44 ^g	100 ^a	45.29 ^{bc}	М
23	FWS9	KR139819	Sialkot	59.26 ^d	100 ^a	52.24 ^c	М	0 ^k	0 ^f	17.13 ^k	Α
24	FWL5	KR139820	Layyah	65.18 °	100 ^a	67.74 ^b	М	0 ^k	0 ^f	16.47 ^k	А
25	FWL6	KR139821	Layyah	100 ^a	100 ^a	100 ^a	Η	44.44 ^g	100 ^a	43.12 ^{bcd}	М
26	FWL7	KR139822	Layyah	55.55 ^{ef}	100 ^a	47.46 ^{cd}	М	0 ^k	0 ^f	23.52 ^{hijk}	А
27	FWL9	KR139823	Layyah	100 ^a	100 ^a	100 ^a	Η	63.7 ^b	100 ^a	46.54 ^{ab}	М
28	FWL12	KP297995	Layyah	100 ^a	100 ^a	100 ^a	Η	66.66 ^a	100	53.68 ª	М
29	FWB10	KR139824	Bhakkar	100 ^a	100 ^a	100 ^a	Н	54.07 ^d	100 ^a	44.71 bed	Μ
30	FWK1	KR139825	Khushab	60 ^d	100 ^a	53.24 ^c	М	1.48 ^{jk}	20 ^{de}	30.69 ^{fgh}	L
31	FWK2	KR139826	Khushab	89.62 ^b	100 ^a	100 ^a	Η	44.44 ^g	100 ^a	46.77 ^{ab}	Μ
32	Control	-	-	0 ^h	0 ^b	0 ^g	Α	0 ^k	0 ^f	0 ¹	Α
LSD Value at $\alpha = 0.05$			3.0	0	8.98	-	2.96	9.42	8.18	-	

Data based on mean of three replications, At α =0.05 level of significance means sharing same letters are non-significant, DR = Disease.

Reaction, H= Highly, M= Moderately, L= Low Virulent and A= Avirulent.

Sequencing of TEF-1α and phylogenetic analysis Use of morphological characters for identification of species under the genus *Fusarium* is often considered time consuming and needs vast experience to differentiate among closely related species (Baayen *et al.*, 2000). Therefore, molecular techniques based on PCR offer a rapid and consistent mean for detection, identification and differentiation of morphomolecularly close *Fusarium* species. They have been proved to be sensitive and specific for diagnosis of several fungal pathogens (Martin *et al.*, 2000; Boonham *et al.*, 2008). Vascular wilt caused by *F*.

oxysporum f. sp. lentis is a devastating pathogen that causes huge yield losses in lentil crop. Early detection of this pathogen is very much essential for effective disease management (Haware and Nene, 1982). In this study, morphological study of the isolates was followed by DNA sequencing and phylogenetics based on the amplification of TEF-1 α nuclear gene region for species identity. Sequencing of TEF-1a nuclear gene region was analyzed for each selected type isolate under study for species identification and phylogenetic analysis.

The sequenced data of each isolate has been deposited in Genbank database under accessions KP297995 and KR139797 to KR139826.



Fig. 1. *Fusarium oxysporum*. A-C: Colony morphology on potato dextrose agar medium, A: Pinkish colony color, B: Fluffy white growth, C: Dark violet pigmentation on the under surface of plate; D: Macro-conidia; E: Micro-conidia of single-celled and 2-celled oval shape; F: Conidiogenous cells; G–I: Formation of Chlamydospores, G: Singly, H: Pairs, I: Short chains; D - I, scale bar = 25 μm.

The primers ef1 and ef2 amplified a single band of size 700bp in all the isolates (Fig. 2) as illustrated by Geiser *et al.* (2004). The database blast results showed 99 to 100% similarity of the sequences with *F. oxysporum*, which was also revealed through phylogenetic analysis. The phylogenetic tree inferred from the partial TEF-1 α sequence data of each isolate is presented in fig. 3. ML-BS analysis of the TEF-1 α provided support for the recognition of

morphologically identified isolates within the *F*. *oxysporum* species complex clade. All the isolates nested within the clade forming a monophyletic group and the sequence data separated the isolates into a strongly-supported lineage (BS = 100%). The earliest diverging lineage comprising of *Gibberella fujikuroi* species complex was not supported by bootstrapping but showed strong (BS = 100%) support with the *F*. *oxysporum* species complex lineage.

The 31 Pakistani isolates studied were obtained from different locations of the lentil growing region of the Punjab. The isolates grouped under a single lineage but within the lineage grouped separately with specific type strains. Within the lineage, the isolates showed varied bootstrap support with the type strains, such as, isolates FWJ2 and FWJ4 from district Jhelum resolved with the type strain MUCL14162 with strong support (BS = 86%) and NRRL 25603 (BS = 97%).



Fig. 2. PCR amplification products (700bp) of genomic DNA of 31 *Fusarium* oxysporum f. sp. *lentis* isolates at 53°C annealing temperature using primers ef1 and ef2. Lane M= 1kb DNA ladder (New England Biolabs, Ipswich, MA).

The rest of the isolates also resided under strongly support bootstrapping (BS = 90%). Isolates FWL6 from district Layyah resided close to the strains NRRL32154 and NRRL32156 with no support value. The next group with low support (BS = 52%) included six isolates obtained from district Chakwal viz. FWC8 and FWC10 and one isolate FWB10 from district Bhakkar. These formed grouping with the strains viz. NRRL43668, NRRL53121, NRRL52787, NRRL34936, NRRL52785 and NRRL32153 with low to strong bootstrapping support (BS = 57 - 77%). The next group within the lineage showed low support (BS = 56%), where two Chakwal isolates viz. FWC15 and FWC21 resided alone but with strong support (BS =

92%) and rest of the isolates grouped with the type strains. This group also resolved with low bootstrapping support (BS = 61%). Isolates from district Khushab (FWK1 and FWK2), Layyah (FWL5, FWL7, FWL12 and FWL9), Sialkot (FWS7, FWS1, FWS3, FWS9 and FWS5), Gujrat (FWG13 and FWG1) and Jhelum (FWJ16, FWJ14, FWJ15, FWJ35, FWJ11 and FWJ8) resided with the strains (10-110, NRRL52736, NRRL25387, JG22-5, NRRL26871, NRRL32158 and FO-02911) with low support (BS = 52 - 66%). The study did not result in the separation of the isolates according to their pathogenicity. This confirmed that pathogenicity of the tested isolates does not necessarily correlate with the phylogenetic grouping. The use of phylogenetic analysis in addition to morphological characterization greatly helped in the confirmation of recovered wilt pathogens at species level. This was supported by the concept given by Aoki *et al.* (2003) who suggested that phylogenetic techniques help identify new species, which is usually difficult and often impossible by using conventional morphological characters.



Fig. 3. Maximum likelihood phylogenetic tree constructed with partial TEF-1α gene sequences of *Fusarium oxyporum* isolates from lentil. Sequences of the following strains represent sequence type group in the tree: NRRL22944, NRRL13566, NRRL25226, NRRL25486, NRRL13999, NRRL22045, NRRL22016, NRRL22945, NRRL25331, MUCL14162, NRRL25603, NRRL32154, NRRL32156, NRRL43668, NRRL53121, NRRL52787, NRRL34936, NRRL52785, NRRL32153, NRRL25387, NRRL52736, 10-110, JG22-5, NRRL26871, NRRL32158 and FO-02911. *F. beomiforme* (NRRL25174) and *F. concolor* (NRRL13459) sequences were used as outgroup taxa to root the tree.

The results suggested that TEF-1 α gene proved an ideal target for identification of species and thus, can be efficiently used for the detection and identification of *F. oxysporum* isolates. As, numerous studies have indicated that TEF-1 α gene is suitable for differentiation of *Fusarium* species (Baayen *et al.*, 2000; Jimenez-Gasco *et al.*, 2002).

Pathogenicity test

Characterization and identification of pathogenic variability in F. oxysporum f. sp. lentis isolates is imperative for efficient management of lentil wilt through host plant resistance. In present study, 31 isolates of F. oxysporum f. sp. lentis were studied through pathogenicity assay to identify pathogenic variation using two lentil germplasm. The inoculation of lentils confirmed the pathogenicity of 30 (96.77%) isolates of F. oxysporum on line NARC-08-1 (Table 3). Almost similar results were also achieved by Taheri et al. (2010) who found 27 (81.82%) pathogenic isolates out of tested 33 isolates. In case of cv. Masoor-93, 22 (70.97%) isolates confirmed their pathogenicity. Typical wilt disease symptoms illustrated by Bowers and Locke (2000) were used for the pathogenic characterization of the isolates and identification of the highly virulent isolates based on 0-9 disease rating scale (Bayaa et al., 1995). Symptoms induced by inoculated isolates of F. oxysporum on lentil germplasm included plants drooping, yellowing of lower leaves and ultimately drying and death of the plants in the later stage. Internal discoloration of xylem vessels was also seen. In contrast, no disease symptoms were observed on control plants. The incubation period ranged from 20 to 25 days in case of line NARC-08-1 while 30-40 days in Masoor-93.

Data on disease parameters showed difference in virulence level of tested *F. oxysporum* isolates as observed by Belabid and Fortas (2002) and Belabid *et al.* (2004). Disease incidence ranged from 0 to 100% in both germplasm. Disease severity index varied among the two different lentil germplasm i.e. 0 to 100% in NARC-08-1 and 0 to 66.66% in Masoor-93. Yield reduction ranged from 19.33 to 100% (NARC-

o8-1) and 6.47 to 53.68% (Masoor-93). The control plants resulted in 0% infection and yield reduction. The data indicated that the wilt disease is greatly involved in the reduction of plant yield and this yield reduction differed in the two tested germplasm. The result was supported by the concept given by Khare *et al.* (1979) who proposed that yield losses depend on the crop variety.

The inoculations not only helped in identifying and confirming the pathogenicity of the tested isolates but also revealed difference in severity of wilt symptoms that helped in the characterization of pathogens virulence using modified 0-9 disease rating scale as described by Baaya et al. (1995). Based on disease reaction on lentil line NARC-08-1, isolates were characterized as highly virulent (7-9 scale range), moderately virulent (4-6) and avirulent (0). The eight (25.81%) isolates viz. FWC15, FWJ35, FWG1, FWL6, FWL9, FWL12, FWB10 and FWK2 were found to be the most pathogenic and produced highly virulent disease reaction (88.14 to 100% disease severity index and 100% disease incidence and yield reduction) on line NARC-08-1 that caused the death of the seedlings within 25 days after inoculation. The moderately virulent 22 (70.97%) isolates included FWC5, FWC6, FWC8, FWC11, FWC21, FWC22, FWJ2, FWJ4, FWJ8, FWJ11, FWJ14, FWJ15, FWJ16, FWG13, FWS1, FWS3, FWS5, FWS7, FWS9, FWL5, FWL7 and FWK1, which caused moderate infection (44.44 to 66.66% severity index and 100% incidence) and infected plants produced seeds that were found mostly shriveled (37.66 to 67.74% yield reduction). None of the isolate fell under low virulent category and only one isolate (FWC10) was found avirulent (0% infection and 19.33% yield reduction). In case of cv. Masoor-93, isolates were characterized as moderately virulent to avirulent, where 14 (45.16%) isolates viz. FWC15, FWC22, FWJ4, FWJ8, FWJ14, FWJ35, FWG1, FWS5, FWS7, FWL6, FWL9, FWL12, FWB10 and FWK2 were found moderately virulent with 44.44 to 66.66% severity index, 87.7 to 100% incidence and 37.97 to 53.68% reduction in yield, 8 (25.81%) isolates viz. FWC5, FWC6, FWC11, FWJ2, FWG13, FWS1, FWS3 and FWK1 were low virulent (1.48 to

16.29% severity index, 13.33 to 100% incidence and 25.66 to 36.68% yield reduction) while rest of the 9 (29.03%) isolates were avirulent (0% infection and 6.47 to 27.70% yield reduction). The results showed statistically significant difference (p = 0.05)compared to the control plants. The variation recorded towards the disease reaction of the two different germplasm suggested that in the availability of same environmental conditions and amount of pathogen inoculum, the genetic makeup of the plants also plays significant role in resistance reaction of the plants towards the inoculated pathogens (Mohammadi et al., 2012). The wide range of pathogenic variability reported in this study was also reported by Naimuddin and Chaudhary (2009). Reisolated F. oxysporum isolates from wilted plants were identified and confirmed as being the same as that were initially used for inoculations. The study greatly helped in the identification of the pathogenic isolates of F. oxysporum f. sp. lentis prevalent in the country.

Conclusion

The present study reports wide distribution and incidence of lentil wilt disease in the major lentil producing region of Punjab, Pakistan and reveals prevalence of morphologically and genetically diverse isolates of Fusarium oxysporum f. sp. lentis possessing great pathogenic variability. The use of TEF-1α based DNA sequencing along with morphological pathogenic data and for characterization of the isolates greatly enhanced the understanding of the variability within this important fungus. This could ultimately benefit for the management of wilt disease through host plant resistance.

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