



Common vetch *Vicia sativa* L. response to gibberellic acid application (GA₃), supplementary irrigation and its water stress critical stages

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Abstract

Physiological responses to gibberellic acid, irrigation and water stress were investigated in common vetch. It was observed that supplementary irrigation (75 % of soil available capacity) resulted in significant reductions in plant height (20.5%), plant length (15.3%), number of node on main stem (11%), leaflet/leaf (8.5%), weight of 1000 seeds (28%), biomass (65.9%) and seed yield (43.6%), as compared to 25% level of watering. Regression analysis manifested that Vetch yield linearly responded to irrigation levels. Vetch plants treated with 200mg/L GA₃ resulted in significant increases in biomass (37.2%), pod number per plant (43%) and seed yield (32%), as compared to untreated. Moreover, 100 mg/l GA₃ highly exceeded in node number on main stem (8.2%), biomass (7.1%) and seed yield (11.6%). Regression analysis revealed that vetch yield was linearly related to irrigation levels. Vetch plant treated with 200 mg/l GA₃ grown under 25% level gave the highest plant height (49.33 cm), first fruiting node (12.33), biomass yield (672.67 g.m⁻²), and seed yield (142.33 g.m⁻²). However the lowest values were confined to untreated with 75% level watering in seed yield (79.33g.m⁻²). It was also found that withholding complementary watering during the pod swelling and seed fillings resulted in profound reductions in weight of 1000 seeds (5.2%), biomass yield.m⁻² (26.8 g) and seed yield per m⁻² (23%). However, first fruiting node (33.3%) and pod number per plant (25.7%) were significantly increased, as compared to continuous watering.

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Introduction

Common Vetch is a vine, succulent, annual legume attaining a height of 24 inches when planted alone. It grows taller when planted with a tall companion crop that provides structural support for climbing. Stems are thin, branched, and usually smooth. Leaves are composed of 4 to 10 paired leaflets, terminate with a tendril, and usually are smooth. Leaflets are broader and appear more succulent than those of hairy vetch (Sattel *et al.*, 1998). Vetches are winter growing legumes with weak to moderate stem strength and viney growth habit. These are used to produce fodder, hay, grain or green manure while providing the rotational benefits of legumes on fine textured neutral to alkaline and shallow duplex soils (Bull and Mayfield, 1992). Common Vetch has a taproot that can reach depths of 3 to 5 feet. In a vetch the main stem soon stops and strong side branches are developed from the base. In this respect it acts like those plants which start growth late in the season, rest during the winter and finish development the next year. They are called winter annuals and require a period of rest in order to develop properly. With Common Vetch, which is sown in spring on account of its tenderness, the resting period is very short. However, if the first part of the summer is cool, the plant may remain in a typical seedling stage for many weeks, thus proving its relation to winter annuals. Vetches are drought tolerant and can be grown on slopes. These can also regenerate naturally from the seed shattered during the previous year. These qualities have rendered them as potential winter forage crop (Hughes *et al.*, 1969). Irrigation deficit resulted in decreased productivity of most crop plants and lead to marked changes in the growth pattern of plants (Clemens *et al.*, 1983).

Common Vetch (*Vicia sativa* L.) is a grain legume crop that is well adapted to the low rainfall areas of southern Australia. The crop can be used for grazing, hay production, green manure or harvested for its grain. However, high concentrations of a neurotoxin

(γ -glutamyl- β -cyanoalanine) in the seed of current cultivars limit its use as a feed grain and preclude its use as a pulse. Reducing toxin levels in the seed to 0.4% or less would allow the grain to be used as a source of protein in pig and poultry feed rations (Rathjen, 1997). In the South-eastern Anatolia region, the rainfall limits plant growth, while the Cukurova region has much better soil and climatic conditions. Since local climatic variation is significant, each location in each year is treated as a separate environment, to give 8 environments (Yucel *et al.*, 2009). Inconsistent genotypic responses to environmental factors such as rainfall, temperature, pests, and soil fertility level over locations and years are a function of genotype \times environment (GE) interactions (Rao *et al.*, 2002).

Phytohormone application resulted in an obvious increase in the contents of nitrogen fractions (soluble, in soluble and total) in the different organs of the water stressed maize, cowpea and broad bean plants (Ahmed *et al.*, 1989). This may be due to activation of protein synthesis exerted by the exogenous phytohormone treatment (Bejaoui, 1985). Hormonal treatments (IAA, GA₃ or kinetin), resulted in a significant increase in carbohydrate contents, whatever the moisture content used, plant tested and the organ analyzed. This stimulatory effect exerted by the three phytohormones may be attributed to the obvious increase in leaf area as well as in the number of stomata, which consequently lead to the increase in photosynthetic activity (Ahmed *et al.*, 1989). In fact these interpretations cannot be taken seriously, since stomata number increases reflected high drought negative influence on cell expansions, and thus stomata population would be increased (Abdel, 2009). However, plant growth promoters manifested their capability in ameliorating water stress was emphasized immediately after irrigation until the depletion of soil water available capacity (AWC) exceeded 50% in most vegetable crops (Abdel and Al-Saleem, 2010), AWC depletion beyond 50% tended to

shift the plants into drought breaking point where, plants endure severe water stress by which phytohormones abrogated and no more being able to aid plant growth. Stomata increases was confirmed by Redmann (1985) reported changes in levels of leaf rolling, leaf dimensions, and stomata densities on adaxial and abaxial leaf surfaces in grass species in dry and wet habitats. This is the first report on changes in the levels of endogenous phytohormones and anatomical structure during leaf rolling in plants. A considerable increase in acid phosphatase activity was observed in embryos under GA₃ and NaCl treatments; however, alkaline phosphatase activity was substantially higher under all treatments.

In endosperm, a significant increase in acid phosphatase activity was observed under ABA and NaCl treatments (Sharma *et al.*, 2004). Moreover, alkaline phosphatase activity was apparently higher under GA₃. However, no substantial changes in acid or alkaline phosphatase activities were observed after drought treatments. These findings suggest that changes in the phosphatase enzymes might play important roles in adaptation of germinating seeds, to changing environmental conditions. Based upon these results, a possible physiological role of phosphatase in germinating sorghum seeds is discussed. Hosoki *et al.* (1987) noted that the level of Gibberellic acid (GA₃) in melon cultivars decreased under drought stress. Gibberellins reduction is usually confined by the increase in ABA level may be related to the adaptation mechanism during leaf rolling in *C. setosa*. Furthermore, water stress had no effect on GA₃ levels in sunflower shoots or roots (Hubick *et al.*, 1986). In contrast (Benson *et al.*, 1990) provided evidence that low water potential might cause a reduction in endogenous GA₃ concentrations in hypocotyls of soybean. There is evidence that other plant hormones also modify GA metabolism, allowing integration between different hormone signaling pathways. The best characterized interaction is with auxin, the action

of which results in increased GA concentrations (Hedden and Thomas, 2006).

These experiments orchestrated for evaluation the response of Common Vetch to supplementary irrigation and rainfall incidences in Erbil, and also to detect the extent that Gibberellic acid (GA₃) could participate in improving the growth and yield performance of this crop under rainfall and adequate watering.

Materials and methods

Two experiments were conducted at the research field belong to Field Crops Department, Agriculture College Salahalddin University, Erbil, Kurdistan Region, Iraq which is located on 36° 10'N Latitude 43°E longitude and 415m above sea level. Seeds of lentil cultivars were bought from agricultural glossaries, since these cultivars are very familiar to growers and highly accepted for public consumption. Split plot arranged in Randomized Complete Block Design (Split- RCBD) was chosen. The main plot (A) in experiment 1 was irrigating plants whenever 25 (a₂), 50 (a₃), and (a₄) 75% depletion from the soil water available capacity (AWC) to a soil depth of 30 cm. Whereas, factor (A) of experiment 2 was irrigating plants whenever 25% Soil AWC is depleted throughout the growing season (a₁), ceasing irrigation during the vegetative stage (a₂), flowering stage (a₃), and pod swelling and seed fillings (a₄).

Therefore, Randomized Complete Block Design was selected for experiment 2. Supplementary watering treatments were separated from each other's by 4m to prevent water seepage. Sub plot of experiment 1 was three gibberellic acid rates 0 (b₁), 100 (b₂) and 200mg.l⁻¹. 12 and 4 treatments were included in experiments 1 and 2, respectively. Each treatment was replicated three times and every replicate contained 1m² planted with 5 rows 20cm apart and 5cm intra plant space. Experiment lands were plowed horizontally and vertically then dissected to fit the

designs previously proposed for both experiments. Gypsum blocks were settled to a depth of 30cm and equally distributed at rate of 1 gypsum block per replicate, to track the soil water fluctuation and to determine watering time precisely. Therefore treatments of 25, 50 and 75% soil water depletions were irrigated 6, 3 and 0 times respectively (Fig. 1).

Meteorological data was obtained from Meteorological Station, Erbil, close to the experimental field (Table 1). Seeds were sown on January 6th 2010 after the occurrence of considerable rainfalls. Benomyl and Beltanol encompassed fungicides were sprayed on April 5th and 20th 2010 to control soil borne disease. Weeds were manually controlled during the growing season. Plants were harvested on June 5th 2010 and samples were taken to the laboratory to measure the detected parameters. Inflorescence number at mean stem, node number per main stem, branches number per plant, leaflet number per leaf, first fruiting node and pod number per plant, number of seeds per pod were counted. Plant height (cm), plant length (cm), pod length (cm) and internodes length (cm) were measured by roller, and finally biomass production g.m⁻², weight of 1000 seeds, Biomass yield/ m² and Seed yield / m² were weighed by electrical balance of 2 decimal. Harvest index was calculated from dividing seed yield / biomass yield. Finally, data were analyzed by computer statistical program, using Duncan's Multiple Range Test at $P = 0.05$ probability level.

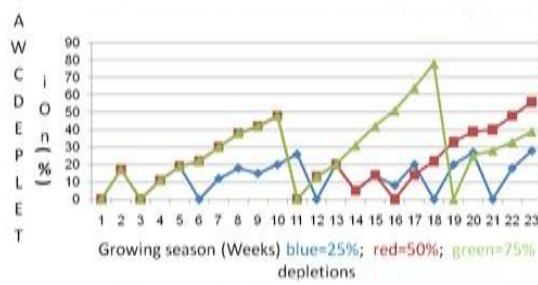


Fig. 1. Rainfall incidences irrigation frequencies and soil AWC depletion (%) during lentil and vetch growing season.

Table 1. Meteorological data during Common Vetch growing season.

Recorded parameters	January	February	March	April	May	Means	
Temperature (C°)	Max. T	19.2	19.8	25.5	23.4	32.2	24.02
	Min T.	4.0	3.7	10.3	14.2	16.5	9.74
	means	11.8	12.4	16.4	19.3	26.1	17.2
Relative Humidity (%)	Max.	90.5	87.0	84.4	79.5	88.0	85.88
	Min	40.0	46.0	34.5	44.0	24.0	37.7
	means	66.0	65.4	60.8	59.7	41.6	58.7
Wind Speed (km)	Max	12.1	6.1	11.1	7.8	6.3	8.68
	Min	0.0	0.0	1.0	0.5	0.6	0.42
	means	3.4	2.3	3.4	2.6	2.9	2.92
Rainfall incidences	34.9	74.3	71.0	32.2	25.6	238mm	

Results and discussion

Effect of supplementary irrigation

Supplementary irrigating vetch (Tables 2 and 3) whenever 75 % of soil available capacity is depleted resulted in significant reductions in plant height (20.5%), plant length (15.3%), number of node on main stem (11%), leaflet/leaf (8.5%), and weight of 1000 seeds (28%), biomass (65.9%) and seed yield (43.6%), as compared to 25% level of watering. Similar reductions were found when 75% level was compared with 50% level in node number per main stem (11.7%), weight of 1000 seeds (9.2%), biomass yield (7.8%), seed yield (34.4%) and harvest index (16.8%). Irrigating plants, whenever 50% soil AWC was depletion profoundly tended to reduce plant height (16.1%), weight of 1000 seeds (18.7%) and biomass (32.7%). However it highly increased pod number per plant (80%) and harvest index (24.1%), as compared to 25% level of irrigation. Regression analysis manifested that internodes length, first fruiting node, inflorescence number, pod number, seed number per pod and harvest index were quadratically responded to irrigation levels and other traits were linearly responded (Table 4). These results suggested that water deprivations resulted in severe growth reductions owing to the reduction in cell enlargements caused by low turgour pressure. Stress induced reduction in cellular turgour pressure is necessarily a primary cause of growth inhibition. Biophysical responses to water deficits are response involves changes in tissue extension capacity, as a result of hardening (or softening) of expanding cell walls, and is termed cell wall adjustment. Wall

hardening should increase the capacity of expanding cells to maintain turgour pressure but also acts to inhibit rates of cell expansion growth. The inhibition of cell expansion can lead to reductions in leaf area that limit rates of transpiration loss of soil water reserves. Wall hardening responses to intermittent water deficit episodes, e.g., in irrigated crops, could be undesirable. The survival of irrigated crops is largely assured and induction of wall hardening in the intervals between irrigation could unnecessarily reduce growth and yields (Neumann 1994).

Effect of GA₃

Vetch 200 mg.l⁻¹GA₃ treated plants (Tables 2 and 3) resulted in significant increases, as compared to untreated plants in biomass (37.2%), pod number per plant (43%) and seed yield (32%), as compared to untreated. Moreover, it highly exceeded that of 100 mg.l⁻¹GA₃ in node number on main stem (8.2%), biomass (7.1%) and seed yield (11.6%). However this treatment highly reduced pod length (10.8%) and weight of 1000 seeds (32.7%), as compared to untreated. Plants treated by 100 mg.l⁻¹GA₃ highly increased plant length (23%), node number on main stem (18.8%), first fruiting node (29%) pod number per plant (64.2%), biomass (28.1%) and seed yield (18.2%) as compared to untreated. Moreover, this treatment highly exceeded that of 200 mg.l⁻¹GA₃ in pod length (12.5), pod number per plant (14.8) and weight of 1000 seeds (34.1%). Regression analysis manifested that plant length, leaflet number, internodes length, branches number per plant, inflorescence number/ main stem, pod number per plant, and harvest index were quadratically responded to irrigation levels and other traits were linearly responded (Table 5). Gibberellins are in charged with cell division and cell expansions and these are the means by which GAs mitigate the negative influences of water stress. Evidence is now emerging that stress results in modified GA biosynthesis. Overexpression of DDF1, which encodes an AP2-like transcription factor that is closely related to the DREB

(Dehydration Responsive Element Binding protein) factors involved in stress responses, caused reduced GA content and dwarfism in Arabidopsis (Magome *et al.*, 2004). The GA 20-oxidase gene TaGA20ox1 was shown to be much more highly expressed in the node than in the internodes. This might indicate movement of an intermediate, presumably GA₂₀, from the intercalary meristems to the elongation zone. It is interesting to note that expression of the wheat orthologue of OsGA20ox2 was not detected in the elongating stem, suggesting that different GA₂₀-oxidase genes may control stem elongation in rice and wheat (Hedden and Thomas, 2006).

Supplementary irrigation and GA₃ interaction

Vetch plant (Tables 2 and 3) treated with 200 mg.l⁻¹GA₃ grown under 25% level gave the highest plant height (49.33 cm), first fruiting node (12.33), biomass yield (672.67 g.m⁻²), and seed yield (142.33 g.m⁻²). However the lowest values were confined to untreated with 75% level watering in seed yield (79.33 g.m⁻²) (Tables 2 and 3). The adverse effects of water stress are emerged from the actions of the generative oxygen reactive species (ROS) that generated from metabolic reactions and aggravated under adversities including drought. The increased activity of antioxidant enzymes due to stress and especially in tolerant cultivar more than sensitive ones is of prime importance in the plant defense mechanism against drought by the rapid removal of toxic oxygen radicals (Magome *et al.*, 2004). Improving physiological metabolic reactions performance that gained from GA₃ during the period after watering and mild drought definitely would proceed through the drought episode. Bouquin *et al.* (2001) found that AtGA20ox1 expression was increased by application of epibrassinolide to an Arabidopsis brassinosteroid-deficient mutant. In the stem, IAA from the shoot apex induces PsGA3ox1 expression and suppresses expression of PsGA2ox1 (O'Neill and Ross, 2002). Regulation of GA biosynthesis in the pod is specific for 4-chloro-IAA, which originates from the seed and

enhances expression of PsGA20ox1 and PsGA3ox1 (Ngo *et al.*, 2002 and Ozga *et al.*, 2003).

Table 2. Growth components of common vetch in response to three water depletion levels and three concentration levels of GA₃.

Treatments	Plant height (cm)	Plant length (cm)	Node no.	Leaflet no.	Internode's length (cm)	Branch no per plant	1 st fruiting node
25% AWC depletion	25	47.1 a	72.7 a	19.0 a	11.3 a	3.8a	8.6a
	50	40.5 b	66.8 ab	19.1 a	10.8 ab	3.5a	8.6a
	75	39.1 b	63.1 b	17.1 b	10.4 b	3.7a	8.1a
50% AWC depletion	0	40.1 b	59.7 b	15.8 c	11.3 a	3.7a	7.7a
	100	42.1 ab	73.5 a	18.8 b	10.4 b	3.9a	9a
	200	44.5 a	69.4 a	20.4 a	10.8 ab	3.4a	8.67a
75% AWC depletion	0	45.6 ab	62.3 bc	17.0 ce	12a	3.6 ab	8.6 a
	100	46.3 ab	80 a	19.3 bc	10.6 ab	4.1 a	9.3 ab
	200	49.3 a	76 a	20.6 ab	11.3 ab	3.7 ab	8.0 bc
25% GA ₃ on	0	40.0 c	59 c	16.0 de	11.3 ab	3.6 ab	6.3 d
	100	39.3 c	69 ac	19.3 bc	10.0 b	3.5 ab	10.6 a
	200	42.3 bc	72.6 ab	22.0 a	11.3 ab	3.3 ab	9.0 b
50% GA ₃ on	0	34.67 d	58 c	14.67 e	10.67 ab	3.97 ab	8.3 bc
	100	40.67 c	71.67 ab	18.00 cd	10.67 ab	4.04 ab	7 cd
	200	42 bc	59.67 c	18.67 bc	10b	3.19 b	9 b

Response of vegetative stage

Withholding watering during the vegetative growth (Table, 5 and Appendix, 11, 12) significantly reduced plant height (8.49%), node number per plant (14.9%), inflorescent number on main stem (26.38%), weight of 1000 seeds (11.8%) and biomass yield.m⁻² (11%). However, pod number per plant (17.96%) was highly increased, as compared with continuous watering (check). These results are in agreements with those obtained by Stedule (1998); Manschadi *et al.* (1998) and Chielewski and Kohn (1999). Competitions on photosynthetic assimilate were severe at this stage where generations and differentiations of leaves node flowers pod setting, seed developments and pod maturations are proceeds almost to the end of plant life. Similar results were reported by Chapman and Peat (1978); Kagure *et al.* (1978) and El-Far (1994).

Response of flowering stage

Ceasing supplementary irrigation during flowering stage showed significant reductions in node number on main stem (14.9%), branches number per plant (50%), inflorescence number on main stem (33.3%), pod number per plant (39.3%), weight of 1000 seeds (12.7%), biomass yield.m⁻² (19.5%) and seed yield.m⁻² (15.3%), as compared to continuous supplementary

watering. Exposing crops to water stress during the flowering stage exiguously reduced yield and growth. Since most growth has been accomplished besides plants are usually produce huge number of flowers (Abdel, 1982). Yet, pod swelling which is synchronized flower generation is of higher influence on yield and yield components. Pod developments and seed fillings were the most drought susceptible stage where supplementary irrigation should be applied to improve yield and yield quality. However, other stages were less sensitive, particularly the early vegetative stage (Abdel, 1993).

Table 3. Yield and its components of common vetch in response to three water depletion levels and three concentration levels of GA₃.

Treatments	Inflorescence No./main stem	Pod length (cm)	Pods No. / plant	No. of seeds/pod	1000-seed weight (gm)	Biomass yield/ m ² (gm)	Seed yield/ m ² (gm)	Harvest index (%)
25% AWC depletion	25	7.8	4.2	16.7 c	5.8a	43.6 a	594.4 a	124.6 a
	50	7.6	4.5	30.2 b	6.4	36.7 b	447.6 b	116.6 a
	75	8.2	4.3	27.6 c	6.0	34.1 c	385.2 c	86.7 b
50% GA ₃ on	0	7.6	4.5 a	18.3 c	6.2	41.4 a	390.6 c	93.6 c
	100	8.2	4.5 a	30.1 a	6.2	41.8 a	500.5 b	110.7 b
	200	7.8	4.0 b	26.2 b	5.8	31.2 b	536.1 a	123.6 a
25% AWC	0	8.3 ab	4.3 ab	15 f	6.0	47.0 a	454.0 c	101.6 d
	100	8.3 ab	4.3 ab	17 ef	6.0	50 a	656.6 a	130.0 b
	200	7 b	4.1 ab	18 e	5.6	43 bd	672.67 a	142.3 a
75% AWC depletion	0	7 b	4.6 a	18 e	6.6	40 b	358.0 e	100.0 d
	100	8.3 ab	4.6 a	40 a	6.3	39 b	462.0 c	116.0 c
	200	7.6 ab	4.1 ab	32.6 b	6.3	31.3 cd	523.0 b	134 ab
25% GA ₃ on	0	7.6 ab	4.5 ab	22.0 d	6.0	37.3 bc	360.0 e	79.3 f
	100	8.0 ab	4.6 a	33.0 b	6.3	36.6 bc	383.0 e	86.3 ef
	200	9.0 a	3.8 b	28.0 c	5.6	28.3 d	412.6 d	94.6 ed

Table 4. Responses of common vetch growth and yield traits to varying irrigation levels.

Character	Regression equation	Coefficient of determination (R ²)
Plant height (cm)	Y = 50.259 - 0.160 X	51.1
Plant length (cm)	Y = 77.259 - 0.193 X	18.1
Node No.	Y = 20.296 - 0.038 X	10.1
Leaflet No.	Y = 11.778 - 0.018 X	14.4
Internodes'length (cm)	Y = 4.632 - 0.042 X + 0.0004 X ²	6.5
Branches No./plant	Y = 9.037 - 0.011 X	2.6
1 st fruiting node	Y = 19.889 - 0.449 X + 0.004 X ²	36.9
Inflorescence No./main stem	Y = 8.889 - 0.056 X + 0.0006 X ²	5.9
Pod length (cm)	Y = 3.7 + 0.031 X - 0.0001X ²	5.1
Pods No. / plant	Y = 14 + 0.218 X	28
No. of seeds/pod	Y = 4.333 + 0.082 X - 0.0008 X ²	12.3
1000-seed weight (gm)	Y = 47.741 - 0.191 X	29.4
Biomass yield/ m ² (gm)	Y = 685 - 4.184 X	56.6
Seed yield / m ² (gm)	Y = 147.259 - 0.758 X	51.8
Harvest index (%)	Y = 7.188 + 0.737 X - 0.007 X ²	63

Response of pod swelling and seed filling stage

Withholding complementary watering during the pod swelling and seed fillings resulted in profound reductions in weight of 1000 seeds (5.2%), biomass yield.m⁻² (26.8 g) and seed yield per m⁻² (23%). However, first fruiting node (33.3%) and pod number per plant (25.7%) were significantly increased, as compared to continuous watering. Most biochemical and biological functions are included in this stage, where continuous vegetative growth, initiation of flower primordial and their developments, seed fillings and pod maturations are all synchronized at this stage. Subsequently, the results suggested that faba bean plants should not be deprived of adequate moisture until the closest pod to the apical of branches are matured (Abdel, 1997). Furthermore, the photosynthesis rate of determinate types was high in the pod set area and continued to remain high from pod setting to grain filling (Kagure, 1993). Droushiotis (1985) observed that in all varieties of Common Vetch, dry matter yield increased significantly when harvest was delayed from early flowering to full pod formation stage. However, crude protein content and digestibility declined with advanced maturity but it increased significantly at later harvest stages. Qamar *et al.* (1999) reported that dry matter productivity and quality of forage mixture of vetch and barley are highly better when grown in winter Mediterranean type season at Islamabad being potential option to the farmers. Orak and Nizam (2004) concluded that Urem and Kubilay varieties were suitable for forage production among the 11 Common Vetch cultivars. Venora and Blangiforti (2002) observed that two cultivars of vetch Gran Velox and Gran Veliero were well suited to local conditions and produced higher yields with higher 100 seed weight. There were significant differences for plant height between different cultivars. Cultivar Balenciflura exhibited taller plants (88.09 cm) followed by Cyprus local (84.13 cm).

Table 5. Responses of Common Vetch growth and yield traits to varying GA3 levels.

Character	Regression equation	Coefficient of determination (R ²)
Plant height (cm)	$Y = 40.037 + 0.022 X$	15.8
Plant length (cm)	$Y = 59.778 + 0.0227 X - 0.0009 X^2$	38.7
Node No.	$Y = 16.130 + 0.0228 X$	58.9
Leaflet No.	$Y = 11.333 - 0.016 X + 0.00007 X^2$	14.4
Internodes' length (cm)	$Y = 3.754 + 0.005 X - 0.00004 X^2$	20.4
branches No./plant	$Y = 7.778 + 0.02 X - 0.00008 X^2$	13.6
1 st fruiting node	$Y = 8.222 + 0.017 X$	38.3
Inflorescence No./main stem	$Y = 7.667 + 0.01 X - 0.00004 X^2$	5.9
Pod length (cm)	$Y = 4.596 - 0.002 X$	20.5
Pods No. / plant	$Y = 18.333 + 0.196 X - 0.0008 X^2$	34
No. of seeds/pod	$Y = 6.278 - 0.002 X$	3.9
1000-seed weight (gm)	$Y = 43.296 - 0.051 X$	33.6
Biomass yield/ m ² (gm)	$Y = 403.056 + 0.727 X$	27.4
Seed yield / m ² (gm)	$Y = 94.37 + 0.15 X$	32.4
Harvest index (%)	$Y = 24.148 - 0.026 X + 0.00001 X^2$	5.3

Table 6. Growth and yield characters of Common Vetch in response to four irrigation types.

Treatments	Plant height (cm)	Plant length (cm)	Node No.	Leaflet No.	Internodes' length (cm)	Branch No./plant	1 st fruiting node	
Continuous watering	42.6 ab	66.3a	18.0 a	10.67	3.45a	9.00 a	6.00 bc	
Vegetative stage	39.3 c	59a	15.6 b	10.67	3.77a	7.67 ab	7.67 ab	
Flowering stage	42.0 b	56.6a	15.6 b	12.00	3.66a	6.00 b	5.33 c	
Seed filling	43.6 a	62.3a	18.0 a	11.3a	3.47a	9.33 a	8.00 a	
Treatments	Inflorescence No./main stem	Pod length (cm)	Pods No. / plant	No. of seeds/pod	1000-seed weight (gm)	Biomass yield/ m ² (gm)	Seed yield/ m ² (gm)	Harvest index (%)
Continuous watering	8.0 a	4.33	26.0 b	6a	47.33 a	643.3 a	141 a	21.85a
Vegetative stage	6.3 b	4.8a	30.6 a	6.3a	42.33 c	579.3 b	131.3 ab	22.68a
Flowering stage	6.0 b	4.5a	18.6 c	5.7a	42 c	538.3 c	122.33 bc	22.72a
Seed filling	7.0 ab	4.6a	32.6 a	6.00	45 b	507.3 d	114.7 c	24.01a

The cultivar Kohak produced significantly smaller plant than all cultivars but statistically similar to Longvedock. Dhumale and Mishra (1979) reported that fresh fodder yield was positively correlated with plant height, leaf area and number of branchess per plant. Plant height at maturity varied due to different genetic constitution of the cultivars. Significant differences were detected in number of leaves per branch among different vetch varieties, where

maximum number of leaves per branch were found in Balenciflura (18.33) followed by Cyprus Local (18.16). Less number of leaves per branch was observed in Longveddock and Kohak (Gurmani *et al.*, 2006).

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