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Determination of appropriate fertilizer application time in bean cultivation in the way of plant optimum nutrition and sustainable agriculture

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Abstract

In order to study integrated application of bio-fertilizers and chemical fertilizers and their application time on quantitative and qualitative yield of navy bean an experiment was arranged during 2013 in factorial based on randomized complete block design in three replications at research station farm of faculty of agriculture, Islamic Azad University, Marand Branch. Treatments were three levels of Nitrocara fertilizer (non-application (control), application at sowing stage and application in complete emergency stage) and nitrogen chemical fertilizer at four levels (non-application (control), application at sowing stage and application in complete emergency stage and application in flowering stage). Results showed that maximum shoot dry weight was related to bio-fertilizer application at complete emergency treatment. Soil test analyze results indicated that bio-fertilizers increased phosphorous, potassium and microelements availability in soil. Although completely replacement of chemical fertilizers with bio-fertilizers decreased the navy bean yield, however, integrated application of them besides the increasing of yield decreased chemical fertilizers using. Thereby bio-fertilizers in sustainable agriculture could be as supersede of chemical fertilizers which could soluble the insoluble form of nutrients during the biological process that reflected in better root development and seeds germination.

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Introduction

Beans is a main and major crop in many parts of the world, particularly in Central America and Africa and is a great meal without the cholesterol supply to the human to provide protein, phosphorus, iron, B vitamins and fiber (Anderson, 2003). Bean with 20-25% protein has as equal as meat protein alternative to meat (Ling *et al*., 1984, Costa *et al*., 2006) which is very important for developing countries (France *et al*., 2000). When legumes are in rotation with other crops, they can improve soil fertility and reduce the spread of weeds, pests and diseases. (Lopez- Blido *et al*., 2005). It should be noted that despite the need for soil and crop nutrient supply it must be in form that besides the providing agronomic needs prevent their waste pollution. There are reports indicating that two-thirds of inorganic nitrogen in agricultural systems is lost through the leaching, sublimation, runoff and erosion (Bysvas *et al*., 2008). This would exacerbate the greenhouse effect, pollution of groundwater to nitrate (Rjsvs and Horn Becker, 1999) and reduce the economic efficiency of agricultural systems. Use of renewable resources and inputs is one of the most principles of sustainable agriculture which led to the maximum agricultural efficiency and minimum environmental risks (Kyzylkaya, 2008). Access to good performance and risk reduction strategies means requirement of using modern farming techniques such as bio-fertilizers application (Hegde *et al*., 1999). Bio-fertilizers are bacterial and fungal micro-organisms that beside the biological nitrogen fixation and phosphorus solubilizing in the soil solution, especially in areas where the soil is high in calcium, with producing significant amounts of growth hormone mainly of auxin, gibberellin and cytokinin have effect on the growth and yield of crops and soil (Zahir *et al*., 2004). Today to ensure the sustainability of agricultural production systems, bio-fertilizers, could be an alternative fertilizers and in some cases could be as a supplement to chemical fertilizers in most cases, (Vessey *et al*., 2010) This study examined the effect of bio-fertilizers (Nitrocara) and nitrogen fertilizers in various stages of both sowing and growing periods to determine the most appropriate fertilizers application time in order to protect the environment, improve nutrition of bean and increase quantitative and qualitative yield of bean.

Materials and methods

This experimental was carried out in 2013 year at agricultural research station farm of Islamic Azad University of Marand Branch with an average annual temperature 10 ° C, 16° C mean annual temperature and minimum mean annual temperature 2/2° C. The soil of the region is Loamy sand and soil PH test run in the range of low to moderate alkalinity. In this study, a factorial experiment was arranged based on randomized complete block design with three replications. Studied factors include B: the use of bio-fertilizer (Nitrocara) in three levels include: b1: non-application of fertilizer b2: contaminated seeds in sowing stage and b3: complete emergency stage and C: nitrogen fertilizer application stage in four levels including: c1: non application c2: sowing stage c3: complete emergency stage and c4: flowering stage. Marand regional bean variety with unlimited growth habit and 90% viability was used. Nitrogen fertilizer recourse used in the experiment: 200 kg ha urea that (in sowing, emergence and full flowering stages) placed 5 cm below the plant and bio-fertilizer used in the experiments was: Nitrocara contain Azorhizobium bacteria. These bacteria are corporate with plant roots around, root surface, intercellular tissues of stem and root. In the full emergence stage 200 g Nitrocara mixed with 20 liters of water and applied to the plant below surface. Farming operation: After the first irrigation seeds were sowed at 3 cm depth where the each plot contained 4 row, 60 apart and 3 meter length. The field was irrigated after sowing. Data and means comparison were analyzed by MSTAT-C software and figures were drown by Excel 2010 software.

Results and discussion

Plant height

According to (fig. 1), and plant height means comparison (table 1), application of fertilizers at different growth stages significantly increased plant height compared to control treatment. The highest

plant height was belong to integrated bio and chemical fertilizers at sowing time (86cm) and difference between maximum and minimum plant height was 12.16 percentage (fig. 1). Namvar *et al*, (2012) in investigation of bio-fertilizers and chemical fertilizers effects on yield and yield component of sunflower reported that the highest plant height and 1000 grain weight was achieved from the highest amount of integrated using of bio-fertilizer and nitrogen fertilizer. Tawfik (2008) in study of integrated using of Azotobacter fertilizer and chemical fertilizer on navy bean indicated that integrated using of bio-fertilizer and chemical fertilizer increased the plant height. Singer *et al*, (2002) evaluated effect of chemical and biological fertilizers on improvement of quality and quantity yield of green bean in sandy soil and found that application of these fertilizers could increase plant growth and height. Effect of Azotobacter and Azospirillum on nutmeg tree have shown that abortive PH optimized condition for more Azotobacter and Azospirillum bacteria activities which let to high plant height in this PH (Nair and chander, 2001). In about bio-fertilizers effect on increasing of plant height, it should be suggested that this could be related to more nutrient uptake specially nitrogen and phosphorous which improved photosynthesis and subsequently increased plant growth rate. As gibberellin caused to cellules elongation and auxin and cytokinin stimulate cellule deviation hence, using of these hormones may be increase plant height (Zahir *et al*., 2004).

Table 1. Analysis of variance of some characteristics.

Means square					
S.V	df	Shoot dry weigh (g)	Grain yield per m2	Pod number per m2	Plant height
repeat	2	9/2862*	0/002^{ns}	1/33^{ns}	3/45^{ns}
Bio-fertilizer	2	15/8352**	35/143 **	20/1490**	25/3851**
Chemical fertilizer	3	33/8667**	22/654**	45/6159**	12/079**
Bio*chemical fertilizer	6	33/8662**	32/743**	38/1063**	4/4617**
error	22	2/6861	6/002	34/66	48/76
C.V (%)	-	8/87	1/01	1/48	1/82

Pod number

According to figure 2 and means comparison of pod number per m² (table 1), its revealed that fertilizer treatments had significant effect on pod number compare to control treatment and maximum of this value with average 273 number was related to application of N fertilizer at flowering stage. Difference between maximum and minimum pod number was in about 6.76% (fig 2). Sehiali *et al*., (1981) mentioned that application of more than 50 kg\ha nitrogen fertilizer increased the pod number per plant compare to control treatment. Elkramany *et al*., (2007) investigate replacement of chemical fertilizers by bio-fertilizer on groundnut and reported that the highest pod number was belonging to 75% chemical fertilizer and 25% bio-fertilizer treatment. Bildirici and Yilmaz (2005), investigate bacteria inoculation at four levels on bean and have shown that by increasing of nitrogen fertilizer to more than 60 kg\ha at flowering stage pod number increased, in fact pod number is related to plant height where by increasing of plant height pod number was increased.

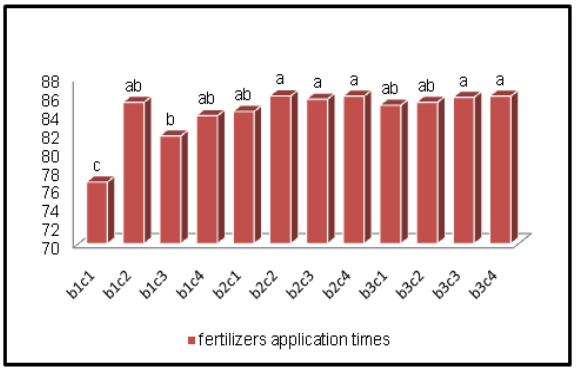

Fig. 1. effect of integrated fertilizers application at different growth period on plant height.

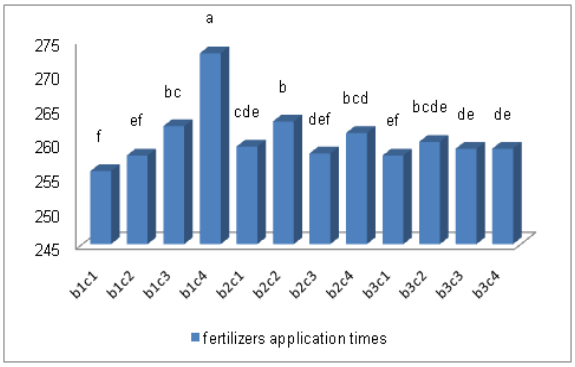

Fig. 2. effect of integrated fertilizers application at different growth period on pod number per m².

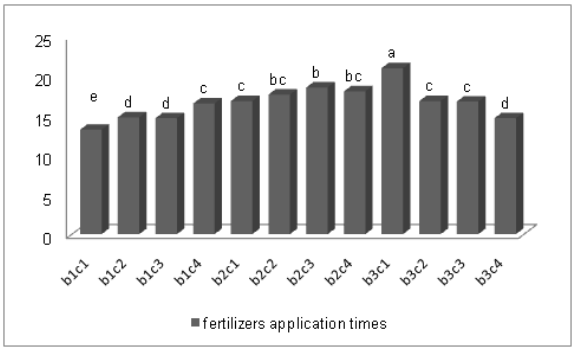

Fig. 4. effect of integrated fertilizers application at different growth period on shoot dry weight per plant.

Grain yield

According to figure 3 and means comparison of grain yield per m² (table 1), it's revealed that fertilizer treatments had significant effect on grain yield compare to control treatment. Maximum grain yield was achieved from integrated application of chemical and bio-fertilizer in complete emergency and flowering stages (270 g).Difference between maximum and minimum grain yield were 6.88 percentage (fig 3). According to Mishra *et al.*, (2010) study, integrated using of chemical and bio-fertilizers improved growth and yield of field pea. Sexena (1993), reported that inoculation of lentil seeds varieties by Rhizobium increased nodes and grain yield. Sivaramaiah *et al.*, (2007) found that inoculation by Rhizobium significantly increased pea yield. Tohidi-Moghadam *et al.*, (2008), reported that soybean grain inoculation by Azospirillum and phosphate solubilizing bacteria with a half amount of nitrogen and phosphorous fertilizers increased grain yield and NPK uptake compare to just chemical NPK fertilizers application.

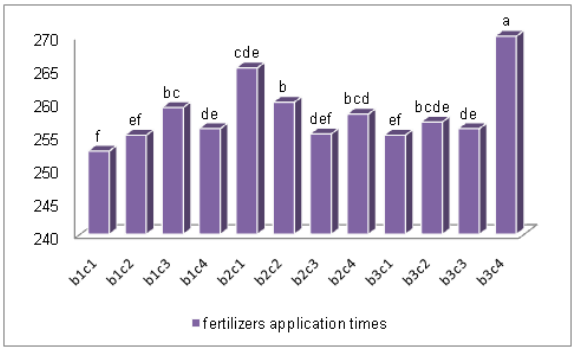

Fig. 3. effect of integrated fertilizers application at different growth period on grain yield per m² .

Shoot dry weight

According to figure 5 and means comparison of shoot dry weight (table 1), application of fertilizer treatment at different growth stages had significant effect on shoot dry weight per plant compare to control treatment and the highest shoot dry weight (20.98 g) was related to bio-fertilizer application at complete emergency stage. Differences between maximum and minimum shoot dry weight was 58.93 percentages. Tilak *et al.*, (1992) in a greenhouse study resulted that integrated inoculation of Azotobacter and Azospirillum had positive effect on dry weight of maize and sorghum plants. Application of bio-fertilizer increased the dry weight of maize which is related to more nutrient uptake and subsequent better plant growth (Hegde *et al.*, 1999). Mirza *et al.* (2000) reported that although application of bio-fertilizers fixed nitrogen, however, product auxin which this increase hairy roots that increased nutrient uptake and dry matter production.

Conclusion

By comparing of effects of bio-fertilizers and nitrogen fertilizer with control treatment it is resulted that application of these fertilizers had positive effects on cultural characters. According to the results bio-fertilizers had less effect on plant yield and yield components increasing compare to chemical fertilizers and this means that alone bio-fertilizer cannot replace chemical fertilizers, but it can be used as a supplement along with chemical fertilizers which decrease the bio-fertilizers efficiency. These improve sustainability of navy pea production system and optimized chemical fertilizers usage in sustainable

agriculture approach. Bio-fertilizers also play a role in increasing the availability of nutrients, especially phosphorus, chemical and biological soil conditions are improving. In this experiment optimum nitrogen fertilizer application time for increasing of yield and yield components was flowering stage with integrated using of bio-fertilizers and nitrogen fertilizer at complete emergency stage and flowering stage.

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