Himachal Journal of Agricultural Research 45(1&2) : 76-79 (2019)

Effect of integrated nutrient management on seed yield and quality of soybean (*Glycine max* (L.) Merrill) under mid hill conditions of Himachal Pradesh

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Manuscript Received: 30.06.2019; Accepted: 29.07.2019

Abstract

A field experiment was conducted during *kharif* season of 2018 at Experimental Form of Department of Seed Science and Technology, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, to study the effect of integrated nutrient management on seed yield and quality in soybean (*Glycine max* L). The experiment was laid out in randomized block design comprising of ten treatments with T_1 (FYM @ 10t/ha + 75% RDF), T_2 (FYM @ 10t/ha + 100% RDF), T_3 (Vermicompost @ 5t/ha + 75% RDF), T_4 (Vermicompost @ 5t/ha + 100% RDF), T_5 (FYM @ 5t/ha + Vermicompost 2.5t/ha + 75% RDF), T_6 (FYM @ 5t/ha + Vermicompost 2.5t/ha + 100% RDF), T_7 (FYM @ 5t/ha + Vermicompost 2.5t/ha + *Azotobactor* + 75% RDF), T_8 (FYM @ 5t/ha + Vermicompost 2.5t/ha + *Azotobactor* + 100% RDF), T_9 (FYM @ 5t/ha + Vermicompost 2.5t/ha + *Azotobactor*), T_{10} (FYM @ 10t/ha + Vermicompost 5t/ha + *Azotobactor*). Significantly high 100 seed weight was recorded in treatment T_4 (Vermicompost @ 5t/ha + 100% RDF) which remained at pare with treatment T_8 (FYM @ 5t/ha + Vermicompost 2.5t/ha + Azotobactor + 100% RDF) and T_7 (FYM @ 5t/ha + Vermicompost 2.5t/ha + Azotobactor + 75% RDF). Higher seedling length was recorded in treatment T_7 (FYM @ 5t/ha + Vermicompost 2.5t/ha + Azotobactor + 75% RDF) which remained at par with treatment T_6 (FYM @ 5t/ha + Vermicompost 2.5t/ha + 100% RDF) and treatment T_4 (Vermicompost @ 5t/ha + 100% RDF). Significantly higher vigor index was recorded in treatment T_7 (FYM @ 5t/ha + Vermicompost 2.5t/ha + Azotobactor + 75% RDF) which remained at par with treatment T_4 (Vermicompost @ 5t/ha + 100% RDF) and treatment T_8 (FYM @ 5t/ha + Vermicompost 2.5t/ha + Azotobactor + 100% RDF).

Key words: Seed yield, quality, soybean, integrated nutrient management.

Soybean (*Glycine max* (L.) Merrill) is a leguminous oilseed crop having worldwide adaptation. It is known as "Golden bean" or "Miracle crop". It has become an industrially vital and viable oilseed crop in many parts of the country. India is considered as a secondary center for domestication of soybean. It is considered as a cash crop and is more important because of its high yield potential and nutritionally ideal complement to the cereal based Indian diet.It is the richest source of protein (40%) and oils (20%). Soybean, being rich source of amino acids, unsaturated fatty acids, vitamins and minerals are being widely used in different forms and acquires special importance in Indian and other Asian countries diet as a substitute to relieve from hunger and malnutrition. It also contains minerals like calcium, phosphorus and iron. A number of protein rich products soymilk, soy paneer, soy sauce and soy flour are produced from its seeds. It is also used as poultry feed, livestock feed and in aquaculture, Its oil is widely used as edible oil and also as raw materials in manufacturing of antibiotics, paints, varnishes adhesives and lubricants, It has a medicinal value and widely used in processed food and beverage industries. Hence, soybean finds diverse utilities as an oil protein, medicine and industrial important crop.In India it is cultivated over an area of 9.79 m hectares with production of 10.05 m tones and an average productivity of 1027 kg/ha. In Himachal Pradesh it is cultivated on 0.6 thousand hectares area with a total production of 0.4 thousand tones. The average productivity of soybean in the state is 667 kg/ha. It is an important crop in Northern hill zone of the country and can be cultivated successfully up to 1300 meters above mean sea level. The climatic condition of the hill areas is suitable for soybean cultivation. Cultivation of soybean in Himachal Pradesh on large scale can be extremely useful, attractive and an economic venture. Keeping in view these factors, the present investigation was planned to study the effect of integrated nutrient management on seed yield and quality of soybean.

Materials and Methods

The experiment was conducted at Experimental Farm of Department of Seed Science and Technology, College of Agriculture, Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur during Kharif 2018 season. During the crop season the weekly maximum and minimum temperature ranged from 32.9 to 23.6°C and 10.1 to 20.6°C respectively. Total rainfall of 1309.04 mm was received during the crop season. The weekly relative humidity in morning and evening ranged from 98.3 to 28.1 and 87.6 to 20.0 per cent. The mean weekly sunshine hours ranged from 3.79 to 9.5 hours during the growing season**.** The field experiment was laid out in Randomized Block Design (RBD) and replicated four times during *Kharif* (2018).100 % recommended doses of nutrient @ 20 kg N, 60 kg P_2O_5 and 40 kg K_2O per hectare were applied as basal dose at the time of sowing by band placement in the furrow, 75% doses of nutrient were calculated accordingly, FYM and vermicompost as per treatment were mixed in the soil at the time of land preparation. In Azotobactor treatment seed was treated with Azotobactor culture before sowing. Pendamethalin 30% EC was sprayed @ of 1.5 l/ha for weed control after 2 days of sowing with power sprayer.Seed recovery percentage was obtained by dividing graded seed with the raw seed yieldfor each treatment individually. Protein content of soybean seed from different treatment was estimated by determining nitrogen content. Total N values thus obtained were multiplied with a factor of 6.25 to obtain the protein content.Random samples of graded seeds from the produce of each plot were taken and 100 seeds were counted and weighted.Germination test was conducted in four replication of 50 seeds each by adapting petriplate method as described by ISTA procedures. Petriplates were incubated in germinator. The temperature of 25$\pm$ 1^{0}C and Related Humidity (RH) of 90 % was maintained during the germination test. Germination percentage was worked for each treatment of every replication on 7th day from the day when germination test was performed. The germination percentage was calculated by dividing number of germinated seeds with the number of seeds kept for germination into hundred.

Five normal seedlings were randomly selected on 7th day from each petriplate and length of each seedling was measured from the tip of the primary leaf to the root tip. Mean seedling length was worked out and expressed in centimeters. Five normal seedlings used for seedling length measurements were put in butter paper and kept in hot air oven at 80^{0}C for 17 hours. The weight of the seedlings was recorded and expressed in grams per seedling.

The seedling vigour index was worked out by adopting the method suggested by Abdul- Baki and Anderson (1973) and expressed in number by using following formulae.

Seedling vigour index–1 = Germination (%) x Seedling length (cm)
Seedling vigour index–2 = Germination (%) x Seedling dry wt (g)

Results and Discussion

Seed recovery percentage was not affected by different nutrient management treatment. Numerically high seed recovery percentage was recorded in treatment T_5 (FYM @ 5t/ha + Vermicompost 2.5t/ha + 75% RDF) and low seed recovery percentage was recorded in treatment T_9 (FYM @ 5t/ha + Vermicompost 2.5t/ha + *Azotobactor)* (Table 1). Similar results were also reported by Rana and Badiyala (2015). Protein content was not affected by different nutrient management treatments. It was statistically same in all the treatments. Numerically higher protein content was recorded in treatment T_{10} (FYM @ 10t/ha + Vermicompost 5t/ha + *Azotobactor)* and less protein content was recorded in treatment T_1 (FYM @ 10t/ha + 75% RDF). Similar results were also reported by Rana and Badiyala (2014).

Significantly high 100 seed weight was recorded in treatment T_4 (Vermicompost @ 5t/ha + 100% RDF) and significantly low 100 seed weight was recorded in treatment T_5 (FYM @ 5t/ha + Vermicompost 2.5t/ha + 75% RDF). This might be due to better nutritional supply and availability to the plant under these treatments. Similar results were also reported by Koushal and Singh (2011).Germination percentage was not affected by different nutrient management treatments. It might be due to the fact that nutrient supply have no rule in viability of seeds. Similar results were also reported by Maruthi and Paramesh (2016).

Seedling length

A perusal of the data for seedling length indicated that significantly higher seedling length was recorded in treatment T_7 (FYM @ 5t/ha + Vermicompost 2.5t/ha + *Azotobactor* + 75% RDF) which remained at par with treatment T_6 (FYM @ 5t/ha + Vermicompost 2.5t/ha + 100% RDF) and treatment T_4 (Vermicompost @ 5t/ha + 100% RDF). Significantly low seedling length was recorded in treatment T_1 (FYM @ 10t/ha + 75% RDF) which remained at par with treatment T_2 (FYM @ 10t/ha + 100% RDF) and T_5 (FYM @ 5t/ha + Vermicompost 2.5t/ha + 75% RDF). Similar results were also reported by Singh *et al*. (2013) and Aziz *et al*. (2011).

Dry weight of seedling

Dry weight of seedling was not affected by different nutrient management treatment. Numerically higher dry weight of seedling was recorded in treatment T_4 (Vermicompost @ 5t/ha + 100% RDF) and low dry weight of seedling was recorded in treatment T_1 (FYM @ 10t/ha + 75% RDF). Similar results were also reported by Maheshbabu *et al*. (2008), Maruthi and Paramesh (2016).

Vigor index I

A perusal of the data for vigor index I indicated that significantly higher vigor index I was recorded in treatment T_7 (FYM @ 5t/ha + Vermicompost 2.5t/ha + *Azotobactor* + 75% RDF) which remained at par with treatment T_4 (Vermicompost @ 5t/ha + 100% RDF) and treatment T_8 (FYM @ 5t/ha + Vermicompost 2.5t/ha + *Azotobactor* + 100% RDF). Significantly low vigor index I was recorded in treatment T_1 (FYM @ 10t/ha + 75% RDF) which remained at par with treatment T_9 (FYM @ 5t/ha + Vermicompost 2.5t/ha + Azotobactor) and treatment T_2 (FYM @ 10t/ha + 100% RDF). It was because of germination percentage and seedling length. Similar results were also reported by Maruthi and Paramesh (2016).

Vigor index II

Vigor index II was not affected by different nutrient management treatment. Numerically higher vigor index II was recorded in treatment T_4 (Vermicompost @ 5t/ha + 100% RDF) and low vigor index II was recorded in treatment T_1 (FYM @ 10t/ha + 75% RDF). Similar results were also reported by Maruthi and Paramesh (2016).

Seed recovery percentage

Seed recovery percentage was not affected by different nutrient management treatment. Numerically high seed recovery percentage was recorded in treatment T_5 (FYM @ 5t/ha + Vermicompost 2.5t/ha + 75% RDF) and low seed recovery percentage was recorded in treatment T_9 (FYM @ 5t/ha + Vermicompost 2.5t/ha + *Azotobactor).* Similar results were also reported by Rana (2015).

Table 1. Effect of different nutrient management treatments on protein content, germination and 100 seed weight

Treatments	Protein content (%)	Germination (%)	100 Seed weight (g)
T1	35.0	97.2	10.3
T2	35.5	97.0	10.8
T3	36.0	97.3	12.2
T4	37.3	98.0	12.6
T5	35.8	96.9	11.2
T6	37.3	97.1	12.2
T7	38.0	97.4	12.3
T8	36.8	97.5	12.5
T9	35.3	97.3	12.0
T10	38.1	97.3	16.6
SEm±	1.2	0.2	0.3
CD (P=0.05)	NS	NS	1.0

Table 2. Effect of different nutrient management treatments on seedling length, dry weight of seedling, vigor index and seed recovery

Treatments	Seedling length (cm)	Dry weight of seedling (mg)	Vigor index I	Vigor index II	Seed recovery (%)
T1	18.7	0.24	1818.6	1855.5	88.5
T2	19.8	0.25	1914.8	1914.8	89.3
T3	20.5	0.27	1991.7	1991.7	90.2
T4	21.2	0.28	2080.1	2268.7	89.0
T5	20.2	0.27	1956.9	1956.9	89.8
T6	21.7	0.26	2109.5	2109.5	90.8
T7	21.8	0.27	2122.3	2313.5	89.0
T8	21.2	0.28	2068.5	2480.1	89.3
T9	19.1	0.27	1855.4	1814.6	87.1
T10	20.2	0.26	1959.6	2545.7	87.8
SEm±	0.5	0.02	51.3	60.1	1.7
CD (P=0.05)	1.6	NS	152.3	178.6	NS

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