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Production potential of soybean (*Glycine max* L. Merril) under resource constraints

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Abstract
The field experiment was carried out at the Experimental Farm Agronomy Section, College of Agriculture, Latur, during the Kharif season of 2021 in order to assess the losses resulting from production restrictions in soybeans and to analyze the impact of different constraints on the growth and yield attributes of soybeans. The pH of the clay-textured, somewhat alkaline soil in the experimental plot was 7.8, and its chemical composition included low levels of available nitrogen (125.30 kg ha^{-1}) and medium levels of available phosphorus (18.20 kg ha^{-1}) as well as high levels of available potassium (498.58 kg ha^{-1}). Because of its good drainage, it was ideal for growth. Eight treatments, each with three replications, were included in the Randomized Block Design trial setup. The adoption of the whole package of procedures (T_1) resulted in higher growth, yield attributes, and seed yield (2148 kg ha^{-1}) in soybean production, according to the results. When compared to the whole package of activities, weeding was shown to be the most important limitation of the single production element, causing yield losses of up to 33%. Plant protection came in second with 25% and RDF with 20%. RDF + weeding (T5), RDF + plant protection (T_6), and weeding + plant protection (T_7) were shown to be the two main production restrictions in soybean production, resulting in yield losses of up to 45%, 35%, and 60%, respectively. In comparison to the full package of practices (T_1), the combination of the three factor production constraints RDF, weed management, and plant protection caused a 70% reduction in yield.

Keywords: Soybean, RDF, decrease in yield, removing weeds, defense of plants and constraints

Introduction

Soybean (*Glycine max* (L.) *Merrill)* is a legume crop belonging to the family Leguminosae. It is an important food crop for both humans and animals. It is major source of vegetable oil and contain high quality protein ranging 40-42%. It is also rich in oil (20%), vitamins and minerals.

23% of carbohydrate, 5% minerals and several other components including vitamins. Soybean protein is rich in valuable amino acid lysine (5%) which is most deficient in most of cereals. It contains 60% poly unsaturated fatty acid (52.8% linoleic and 7.2% linolenic acid). Every year, approximately 85 percent of the world's soybeans are processed to make oil and meal. Because oil dries quickly, about 80% of it is used in industry to prepare colors, varnishes, printing ink, oil cloth, detergent, patent leather, and waterproof fabrics. The most precious and possibly most popular feed for cattle is soybean oil cakes.

One major contributor to the edible oil pool in India is soybean. Soybeans currently make up 43% of all oilseeds and 25% of all oil produced in the nation. Because it is the best food for cardiac patients and those who want to prevent heart disease, soybean oil is superior to all other oils. Moreover, it has a significant quantity of lecithin and a moderate amount of fat-soluble vitamin. Crop production mainly depends on the climatic factors as well as agronomic practices. Among the agronomical practice application of fertilizers, weed management and plant protection plays qrole in maximizing seed yield of soybean crop. The various factors that was fertilizer, weeding and plant protection contributes towards the establishment of the crop stand as well as their growth, which ultimately turns into final seed yield of crop. It is critical to identify the restrictions that have an impact on output in order to support efforts to overcome them and develop solutions. Resource constraints are the limits on the fundamental inputs that are available. By identifying the main production constraints for soybeans, resource constraints can be used to place restrictions on essential agricultural inputs as well as cultural practices like weeding, fertilizer, and plant protection, all of which are essential for the crop's better growth and development, higher yield, and profitable profits.

In light of these facts, the current study, "Production potential of soybean (*Glycine max* L. Merril) under resource constraints," was conducted in black soil to examine the effects of different constraints on the growth and yield attributes of soybeans as well as to determine the losses resulting from such constraints.

Materials and Methods

The experiment was carried out in the kharif season of 2021–2022 at the College of Agriculture Latur Experimental Farm Agronomy division. Its goal was to quantify the losses resulting from production restrictions in soybeans and investigate the impact of different constraints on the growth and yield characteristics of the crop. The experimental plot's soil had a clayey texture, a pH of 7.8, a somewhat alkaline response, low available nitrogen (125.3 kg ha^{-1}), extremely low available phosphorous (18.2 kg ha^{-1}), and extremely high available potassium (498.58 kg ha^{-1}). Because of its good drainage, the soil was ideal for growth. The design of the experiment was a Randomized Block Design. There were three replications of the eight treatments. Full set of practices (T_1), RDF (T_2), Weeding (T_3), Plant Protection (T_4), T_5 (RDF + Weeding), T_6 (RDF + Plant Protection), Weeding (T_1), Plant Protection (T_7), and T_8 (RDF + Weeding + Plant Protection) were the treatments. Every test unit's gross and net plot sizes were 5.40 x 4.50 m and 4.5 x 3.9 m, respectively. Using a seed rate of 65 kg ha^{-1}, the dibbling method of seeding was used. For soybean crops, a fertilizer dosage of 30:60:30 kg NPK ha^{-1} was advised. Prior to seeding, the fertilizers were administered in accordance with the procedures. The seeds were sown on July 9, 2021. The suggested cultural customs were followed. In accordance with the treatments, RDF, weeding, and plant protection measures were implemented. Using the fertilizers urea, DAP, and MOP, the dose of fertilizers (phosphorus, potassium, and nitrogen) was applied in accordance with the treatments. The analysis of variance approach (Panse and Sukhatme, 1967) [5] was used to examine data collected on a variety of factors.

Results and Discussion growth attributes

The effects of different treatments had a substantial impact on the growth parameters of the soybean crop, including plant height (cm), number of branching per plant, Leaf Area $plant^{-1}$ (dm^2), and dry matter accumulation (g) per plant (Table 1).

The maximum plant height, number of branches per plant, leaf area $plant^{-1}$ (dm^2), and dry matter accumulation (g) per plant were all recorded when the whole package of techniques was used. These results were shown to be much better than those of the other resource-constrained treatments. Reduce value of mentioned above parameters was shown by combined production factor limitations. The whole package's beneficial effects on these soybean growth metrics may be attributable to the sufficient nutrient supply, which promoted cell division and elongation for optimal development.

Weed and insect management also contributed to the favorable growing conditions for the crop. These findings are in line with those reported by Chaturvedi *et al*. (2012) [2], Gite R.V. (2016) [4], and Bainade *et al*. (2019) [1].

When plant protection limitations, weed control, and RDF were coupled, the amount of dry matter accumulated by each plant was decreased. Crop weed competition for nutrients, water, light, and other resources may be the cause of this, since it eventually decreased the amount of dry matter accumulated by each plant. Similar findings were also published by Gupta *et al*. (2017) [5] and Kalal *et al*. (2018) [6].

Yield attributes

Various resource restrictions had a substantial impact on the yield attributing features of soybean, namely the number of pod plants per plant, the number of seeds per pod, and the seed yield $plant^{-1}$ (g) and seed yield (kg ha^{-1}) (Table 2). The adoption of the whole package of techniques resulted in a considerably larger number of pods per plant (38.10) compared to all other treatments. The use of the whole package of activities resulted in the greatest soybean seed yield $plant^{-1}$ (g) and seed yield (kg ha^{-1}), which was noticeably greater than the other treatments. These outcomes may be the consequence of applying the entire package, which promoted desirable development characteristics and reduced insect, disease, and weed infestation. Gite R.V. (2016) [4] discovered similar outcomes.

Yield reduction due to resource constraints

The three characteristics of soybean yield that are related to number of pods per plant, number of seeds per pod, and seed yield $plant^{-1}$ (g) The seed yield (kg ha^{-1}) was greatly impacted by When compared to the whole package of activities, weeding was shown to be the most important limitation of the single production element, causing yield losses of up to 33%. Plant protection came in second with 25% and RDF with 20%. Out of the two factor production limitations, yield reductions of up to 60%, 45%, and 35% were induced by weeding in conjunction with plant protection (T_7), RDF in conjunction with weeding (T_5), and RDF in conjunction with plant protection (T_6). When the three production-related factors RDF, weed control, and plant protection combined, the yield was 70% lower than when the whole package was applied.

Table 1: Effect of various treatments on growth attributes of soybean

Treatments	Plant height/ plant (cm) at harvest	No. of branches/plant at harvest	Leaf Area/plant at harvest	Dry matter/plant (g) at harvest
T_1: Full Package	46.00	7.00	7.01	22.50
T_2: T1– RDF	39.00	6.10	6.00	19.24
T_3: T1– Weeding	34.50	5.30	5.10	15.25
T_4: T1 - Plant Protection	36.32	6.00	5.50	17.50
T_5: T1- (RDF + Weeding)	31.00	4.75	3.80	13.20
T_6: T1- (RDF + Plant Protection)	33.20	5.26	4.50	15.20
T_7: T1- (Weeding + Plant Protection)	28.24	3.50	3.20	10.80
T_8: T1 - (RDF + Weeding +Plant Protection)	24.36	2.90	3.00	8.60
SE +	1.84	0.32	0.25	0.76
C.D. at 5%	5.37	0.93	0.89	2.21
General Mean	34.08	5.10	4.76	15.29

Table 2: Effect of various treatments on yield attributing characters and yield of soybean

Treatments	Number of pods plant^{-1}	Number of seed pod^{-1}	Seed yield plant^{-1}	Seed yield (kg ha^{-1})	% yield reduction
T_1: Full Package	38.10	3.00	12.45	2148.00	-
T_2: T1- RDF	32.00	2.55	8.64	1719.00	20
T_3: T1- Weeding	29.00	2.33	6.62	1440.00	33
T_4: T1 - Plant Protection	31.00	2.40	7.58	1611.00	25
T_5: T1- (RDF + Weeding)	26.00	2.25	5.49	1182.00	45
T_6: T1- (RDF + Plant Protection)	28.00	2.30	6.11	1397.00	35
T_7: T1- (Weeding + Plant Protection)	23.00	2.00	4.18	860.00	60
T_8: T1 -(RDF + Weeding +Plant Protection)	19.00	1.70	2.90	645.00	70
SE +	1.70	0.11	0.31	80.59	
C.D. at 5%	4.98	NS	0.90	241.77	
General Mean	28.26	2.32	6.75	1335.00	

Conclusion

Based on the aforementioned findings, it was determined that implementing the entire set of techniques was crucial to achieving increased soybean seed yield output. Plant protection was the next most important element in yield decrease, after weeding. The two factors that were shown to be most important for lowering soybean production were weeding + plant protection, RDF + weeding, and RDF + weeding + plant protection.

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