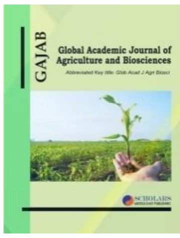
Global Academic Journal of Agriculture and Bio sciences

Available online at https://www.gajrc.com
DOI: 10.36348/gajab.2023.v05i03.003

OPEN ACCESS



ISSN:2706-8978 (P)
ISSN: 2707-2568 (O)

Original Research Article

Validation and Evaluation of the Existing Agronomic Practices for Chickpea Productivity around West Arsi Zone of Shashemene Wereda

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Article History
Received: 02.06.2023
Accepted: 07.07.2023
Published: 04.08.2023

Abstract: The activity was conducted around Shashemene wereda of selected kebele in 2022/23 main cropping season, to validate and evaluate crop management (agronomic) practices for adopting chickpea production on the small holder farmer's field. The study was conducted on selected farmer's field, then training and awareness were created about the experiment before we established on selected host farmer's field. The farmers handled all activities by their own local chickpea agronomic management practice on their own farm. However, the research recommended agronomic practice were carried out by the researchers. We already organized the field day two times i.e., at the time of sowing and while harvesting of chickpea. The participants were actively and seriously evaluated the difference between treatments (local farmers practice and research recommended agronomic practice). Producing of chickpea by row planting, NPS fertilizer application, apron star seed treatment and on time fungicide or insecticide application is much better than their local management practice. So, chickpea sown by recommended management practice has showed better performance. The recommended agronomic practice enables to obtained the maximum grain yield (2,030 kg ha^{-1} and 1,552 kg ha^{-1}) from both Teketay and Natoli varieties respectively. The result of our economic analysis forced to conclude that, planting of chickpea with row spacing, fertilizer application, apron star seed treatment is more economical and advantageous than farmer's local practice.

Keywords: Agronomic practice, Apron star, Economic analysis, Natoli and Teketay.

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is the third most important food legume worldwide grown in 11 million ha with 9-million-ton production. It is grown over 45 countries in all continent of the world. Chickpea is an important food legume mainly produced by smallholder farmers under rain fed condition in Ethiopia. It is adapted to relatively cooler climates. The crop is grown by about 1million households and covering 240,000 ha of land, it is the second major food legume next to faba bean. It is also accounting for 17% of the total food legume production in Ethiopia (CSA, 2020). However, Ethiopian farmers often allocate much of their time and household labours for cereals and chickpea is usually receiving marginal resources. It seems that such perception still exists, and there is reluctance on the side of farmers towards the role of fertilizers in increasing crop yield. This culture of chickpea production a factor for low yield of chickpea in addition of diseases and other environmental factors. Rhizobium inoculation increased plant growth, yield and yield components and nitrogen fixation in Chickpea (Fatima *et al*., 2008). In major chickpea producing areas the farmers used biofertilizer and obtained better chickpea grain yield. To address the product for international markets, farmers have to remain competitive by using high quality seed with suitable agronomic and market attributes, increasing productivity and improving grain quality. Ridge planting may also reduce the problem of poor germination caused by water logging. Spraying 1-2 times, depending on infestation threshold, will suffice (Richard *et al*., 2006). They also stated that for high productivity of Kabuli seed and grain, seed treatment, timely planting (in relation to level of soil moisture-larger seeded Kabulis have poor germination under high soil moisture condition) and spraying against bollworms will be essential.

Chickpeas are a unique pulse as they secrete acid from their root system which unlocks tied up phosphorus from soils, allowing cereals access. Lighter soils or soil types with low or poor phosphorus history may still warrant or get economical responses to P and Sulphur must be considered as well. Moreover, the farmers didn't update the new variety for better chickpea production. Generally, validation and evaluation of agronomic practice in non-traditional chickpea areas is very important and economical. So, this activity is planned with the main objective to validate and evaluate crop management practices for adopting chickpea production on the small holder farmer's field.

MATERIALS AND METHODS

This experiment was conducted around Shashemene wereda of selected kebeles on 2022/23 main cropping season. This research was conducted on-farm research, in chickpea growing areas under rain-fed condition. participatory approaches were used to select host farmers and location with district development agents. The previous best fit chickpea management recommendations that gave the highest yield used as a treatment (Population density, planting method, Variety (Kabuli and Desi type) the chickpea varieties like, Teketay and Natoly were used, which are the most common available for farmers and best performing varieties respectively. We were used four treatments of this experiment.

Treatment 1: Row spacing (30 cmx10cm), 100 kgha^{-1} NPS, Apron star seed treatment (Teketeay)
Treatment 2: Row spacing (30 cm x10cm), 100 kgha^{-1} NPS, Apron star seed treatment (Natoli)
Treatment 3: Local farmer agronomic practices (Broad casting, no NPS, without apron star seed treatment) (Teketay)
Treatment 4: Local farmer agronomic practices (Broad casting, no NPS, without apron star seed treatment) (Natoli).

It was conducted on a plot size of 10mx10m area on farmer's field. At least three farmers' fields in each location were selected and participated. Host farmers were also selected purposively based on their willingness to conduct the trial and accessibility of their respective farms for close follow up and monitoring. All management remained the same except for the farmer practices.

DATA COLLECTION

Farmers' Data Collection

The three different groups of farmers having fifteen members each were selected to rate different traits from emergence to maturity and post-harvest evaluation. Farmers and Agronomists jointly evaluated the treatments, but the farmers alone made the final decision. Traits considered and criteria used for validation and demonstration of agronomic practice on chickpea varieties by farmers were: Disease's reaction, Marketability, Days to physiological maturity, Interest to produce and Overall performance the varieties. All-important data growth, yield components and yield of chickpea was be collected.

Partial budget analysis: it was taken as the standard data collection procedure. In addition to this, farmer's perception was collected by interviews and group discussion. Farmer's opinions and explanations on the FGD (focus group discussion) will be analyzed through qualitative narratives. Training was given for host farmers and development agents (DAs'). Field visit was organized to validate and evaluate agronomic practice of chickpea. The selected 45 and 55 farmers were participated on two field day visit.

Data analysis: SPSS software version 20. was used to analysed farmers perception the farmers perception on the row planting, fertilizer application, bio fertilizer inoculation and varieties of chickpea was analysed. The agronomist data was also analysed by using R-software version 4.32.1. Least significance difference used for mean separation.

RESULTS AND DISCUSSION

Agronomic Management

Establishment of effective symbiosis between rhizobia and the host plant primarily requires optimal conditions that are necessary for growth of the host plants (Ibsa *et al*., 2013). In this regard, agronomic practices have a profound influence on both the soil and the crop under consideration. Agronomic factors that influence BNF by affecting both the crop and the microbial activity in the rhizosphere include tillage practices, selection of effective or responsive crops, appropriate cropping systems, method of sowing, time of sowing, use of agrochemicals, use of Rhizobium cultures and its frequency, the way of handling the inoculants and the method of inoculation (Kantar *et al.* 2010).

Table 1: Economic Analysis for Validation and Demonstration of Agronomic Practice of chickpea varieties at Kuyera Wereda

	Treatments			
Traits	**Teketay with research package**	**Teketay with farmers practice**	**Natoli with research package**	**Natoli with farmer's practice**
Grain yield (kg/ha)	2,030	1,577.1	1,552	1,046.9
Price per kilogram	65.93	65.93	65.93	65.93
Total Revenue	**133,837.9**	**103,978.20**	**102,323.36**	**69,022.12**
Variable costs				
Seed cost (including transport)	6,200	6,500	5,800	5,600
Fertilizer cost (NPS)	3,500	0	3,500	0
Chemicals Cost (apron star & fungicide)	2,700	0	2,700	0
Labour cost (ETB/ha)	2,500	1,200	1,200	2,500
Cost of transport, sacks	350	400	350	400
Total variable costs	**15,250**	**8,100**	**13,550**	**8,500**
Fixed costs (ETB/ha)				
Fixed costs	10,000	10,000	10,000	10,000
Total Cost	25,250	18,100	23,550	18,500
Gross Margin	118,587.9	95,878.2	88,773.36	60,522.12
Profit	**108,587.9**	**85,878.2**	**78,773.36**	**50,522.12**

Where, ETB/ha=Ethiopian birr per hectare

The economic analysis result showed that the profit of Teketay variety (108,587.9 Ethiopian birr per hectare) was obtained from research recommended agronomic practice while, (85,878.2 Ethiopian birr per hectare) was also obtained from local farmers' practice. The financial analysis result showed that we already gained a profit of (78,773.36 and 50,522.12 Ethiopian birr/hectare) from Natoli variety by using research recommended agronomic practice and farmers' practice respectively (Table 1). This indicates that production of chickpea with recommended agronomic practice (row planting, application of NPS fertilizer, apron star seed treatment, use of pesticide and herbicide chemicals) enables to obtained best grain yield for farmers. So, the farmers have to sow and produce chickpea with recommended agronomic practice better grain yield production and profitability.

Table 2: the number of participants at the time of sowing and harvesting for awareness creation on agronomic practices for chickpea production

During time of sowing								
Farmers			**Development agents**			**Researchers + field assistance**		
Male	**Female**	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**
25	20	45	3	1	4	4		4
During harvesting								
Farmers			**Development agents**			**Researchers + field assistance**		
Male	**Female**	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**
25	15	40	3		3	6	1	7

The experiment was established on selected host farmers and awareness was created about the experiment before sowing. The mini field day was also arranged and the participants were observed the research agronomic practice (row planting, NPS fertilizer application, apron star seed treatment) and local farmers practice of chickpea production. About 25 male and 20 female farmers with a total of 45 farmers were attended on this field day (Table 2). The development agents were also attended around 3 male and a female were also attended on the field day. This mini field day was organized by researchers from agronomy research team. The second term field day was also organized before harvesting to evaluate the difference between research recommended agronomic practice and local farmers chickpea production. Around 25 male and 15 female a total of 40 farmers were also attended and evaluate the treatments (Table 2). Similarly other stake holders were attended for this field day.

Row planting vs broadcasting of chickpea

Broadcasting of chickpea is a local farmers practice and they apply high amount of seed rate. This type of sowing is also forced to apply excesses and wastage of fertilizer. It is also difficult for crop management like cultivation, fungicide or insecticide application. However, row planting is alleviating such type challenges and very economical for farmers. High seed rates (120-140 kg ha^{-1}) for large-seeded and low seed rates (65-75 kg ha^{-1}) for varieties with small seed size are recommended (Solomon, 2010). The application of a low seeding rate has no significant effects on seed yield due to the capacity of the crop to produce a large number of branches to compensate for low plant population (Birhanu *et al*. 2020). However, it is essential to use high seed rate in ensuring good plant stand under adverse environmental conditions. The recommendation for row planting of chickpea indicates a spacing of 30cm between rows and 10cm between plants which gives a density of about 333,334 plants ha^{-1} (DZARC, 2004). However, the seed rate by broadcast application method appears to be varying depending up on the seed size of the cultivars and growth habit.

Table 3: Preference scoring of farmers for Agronomic practice on chickpea varieties at the time of field evaluation

Parameters	**Treatments**			
	Teketay with research package	**Natoli with research package**	**Natoli with farmers practice**	**Teketay with farmers practice**
Disease's reaction	4.33	4.00	1.33	2.67
Marketability	4.00	3.33	1.00	2.00
Days to physiological maturity	2.33	4.33	4.00	1.00
Interest to produce	4.00	3.33	2.33	2.67
Overall performance	4.00	3.33	1.00	2.00
Overall score	18.66	18.32	9.66	10.34
Rank	**1**	**2**	**4**	**3**

Application chemical fertilizer

In most cases, farmers in Ethiopia do not use chemical fertilizers in chickpea production (Agegnehu *et al*., 2006). The research centers and other stake holders was conducted fertility needs of chickpeas through different time in Ethiopia. However, this technology is not well-dressed to farmers. The farmers and even researchers have a wrong conclusion fertilizer application for pulse crops like, they said that "chickpeas are minimally or no responsive to fertilization with nitrogen (N), phosphorus (P), sulfur (S), or zinc (Zn)", So, due to such type limited amount of information are generated. The finding of different authors stated that increasing price of nitrogen fertilizer and with growing environ-mental concern, selection of nutrient-efficient host geno-types with effective endosymbionts is a good alternative to overcome the problem of nitrogen deficiency. The recommended fertilizer schedule of chickpea does not have potassium and zinc is important limiting nutrient elements in pulse production (Kachave *et al*., 2018).

Increased in protein content may be due to most important role of nitrogen fertilizer in plant is mainly in its presence in the nucleic acid protein structure for chickpea. In addition, nitrogen is also found in chlorophyll molecule. Chlorophyll enables plant to transfer energy from sunlight by photosynthesis to assimilate (chemical energy form). Therefore, the nitrogen supply to the plant will influence the amount of protein in chickpea (Choudhary and Yadav, 2011). High N fertility can inhibit nodulation and crop nitrogen fixation. Chickpea, like other pulse crops, it requires phosphorus, potassium (K), and micronutrients for growth. Fertilizer can be broadcast, banded, or drilled with seed. However, broadcast applications of P may need to be at a slightly higher rate than banded applications, as P has little soil mobility. Chickpea plants need adequate amounts of sulfur to help them fix atmospheric nitrogen (Corp, 2004).

Table 4. Pair-wise comparison and ranking matrix for selected farmers perceptions for Agronomic practice on chickpea varieties at the time of field evaluation

Parameters	Broad casting (A)	Apron star seed treatment (B)	NPS application (C)	Pesticide & fungicide application (D)	Row planting (E)	Total preference score rate	Rank
Broad casting (**A**)	-------	B0	C0	D0	E0	**0**	**5**
Apron star seed treatment (**B**)	A1	------	C0	D0	E0	**1**	**4**
NPS application (**C**)	A0	B1	-------	D1	E0	**2**	**3**
Pesticide & fungicide application (**D**)	A1	B1	C1	---------	E0	**3**	**2**
Row planting (**E**)	A1	B1	C1	D1	--------	**4**	**1**

Where objectives score=1 is more important and objectives score=0 is less important

Apron Star seed treatment: Apron Star is a seed treatment fungicide-insecticide mixture for controlling downy mildew, damping-off diseases as well as for protection of seeds and seedlings against early season insect pests and soil borne diseases in beans, sorghum, maize, cotton and vegetables. The farmers were actively participated from site selection up to the end of evaluation of the research. They were also appreciated this seed dressing chemicals for alleviating moisture stress occurring during flowering and grain filling stages of the crops by sowing seeds dressed with Apron Star. So, Apron Star has dual purpose for preventing wilt-root complex disease as well as controlling cutworm, because by nature, Apron Star has both fungicidal and insecticidal properties. This chemical also important to avoid the shortage of moisture occurring during late stage (flowering up to maturity) of the crop i.e., it promotes early planting of chickpea as well as reducing moisture stress, diseases and cutworm problems.

Figure 1: It showed the number of participants and awareness creation about the experiment while in sowing

Figure 2: Seed treatment with apron star at the time of sowing and awareness creation for farmers

Figure 3: Showed pesticide spray and the performance of chickpea varieties at early flowering stage

Figure 4: the Second field day and the participant farmers observed the effects of agronomic practice of chickpea

Table 5: The Mean value of Yield and Yield Components of chickpea varieties by the Effects of different Agronomic practices

Agronomic practices	NPP	NSP	HSW	AGB	GY	HI (%)
Row planting + NPS + Apron star seed treatment (Teketay)	54.8	1.4	24.86	7,350	2030	27.62
Row planting + NPS + Apron star seed treatment (Natoli)	51	1.5	25.12	4,550	1,552	34.49
Broadcasting (include local farmers practice (Natoli)	29.8	1.3	21.25	6,400	1,046.9	16.36
Broadcasting (include local farmers practice (Teketay)	42.4	1.3	22.73	4,850	1,577.1	32.52
Pooled Mean	44.5	1.38	23.49	5,787.5	1546.5	27.75
Standard Deviation (Sd)	9.60	0.10	1.84	1,320.05	401.81	8.12

Where, NPP=Number of pod per plant, NSP=Number of seed per pod, HSW=Hundred seed weight (g), AGB=Above ground biomass (kg ha^{-1}), GY=Grain yield (kg ha^{-1}), HI=Harvest index (%)

Grain yield: the maximum grain yield is obtained from the recommended agronomic practice than local farmers production from both varieties (Teketay and Natoli). So, the farmers should be sown chickpea with row planting, application recommended fertilizer and other agronomic management for better grain yield production. The experimental results of Almaz *et al*. (2022) who revealed that economic analysis also revealed that row planting of chickpea varieties gave the highest net benefit. They also stated that the maximum grain yield was obtained from row planting of chickpea. The experimental results of Ibsa *et al*. (2013) of the organic matter content of the soil is influenced by the agronomic management and has several positive influences on soil fertility, moisture holding capacity and microbial activity. This has also an indirect influence the grain yield increment of chickpea. The reduced plant population will be increasing the performance of individual plant. However, this does not indicate that maximum productivity as per a given area of land because of the inefficient utilization of plant growth factors such as moisture, air, space (land). Broadcasting of chickpea enables to reducing plant spacing beyond a certain limit, will not also result in a maximum productivity due to the effect of increased competition for plant growth factors (Li, 2006).

Number of seed per pod: number of seeds per pod is considered an important factor that directly imparts an exploiting potential recovery in leguminous crops. Mean data regarding number of seeds per pod given in Table 5. This showed that the maximum number of seeds per pod (1.5 and 1.4) were recorded in row planting of Teketay and Natoli respectively, while the minimum number of seeds per pod (1.3) was recorded in broad casting of both varieties.

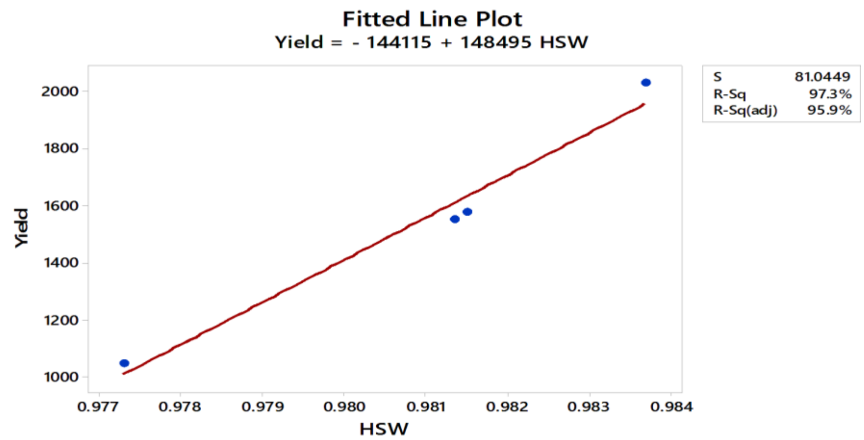

Figure 5: Regression analysis between grain yield (kg/ha) and hundred Seed weight (HSW) (g) of chickpea varieties

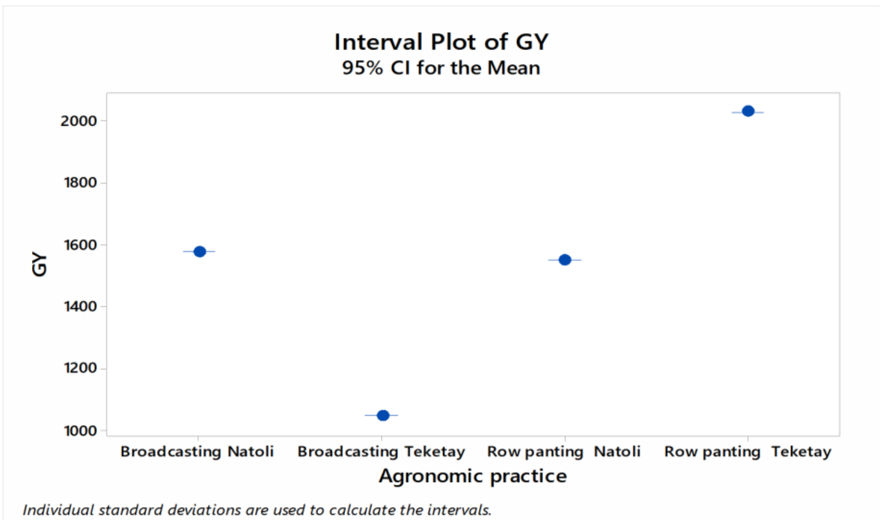

Figure 6: The effects of different agronomic practice on grain yield (kg ha^{-1}) of chickpea varieties

CONCLUSION AND RECOMMENDATION

Chickpea is one of the most important food legumes in the world and in Ethiopia. Several abiotic and biotic factors limit chickpea yields, notably, heat, drought, management practice (agronomic practice) and dry root rot (DRR) disease. Chickpea production and productivity highly affected by agronomic and crop management practice of the farmers in Ethiopia. Agronomic practice include broadcasting, row planting, NPS fertilizer application, seed treatment and disease control through fungicide and pesticide application. However, row planting, recommended rate of fertilizer application, seed treatment and on time fungicide or insecticide spray are enables framers to obtain best grain yield of chickpea. Most of Ethiopian farmers producing chickpea broadcasting method of sowing, no fertilizer application, without fungicide or insecticide control and do not use apron star for seed treatment. The farmers are not willing to invest much of labor force just like other cereal crops. They have got awareness from this activity about the difference between research recommended agronomic practice with that their local production system. The recommended agronomic practice enables to obtained the maximum grain yield (2,030 kg ha^{-1} and 1,552 kg ha^{-1}) from both Teketay and Natoli varieties respectively. The result of our economic analysis forced to conclude that, planting of chickpea with row spacing, fertilizer application, apron star seed treatment is more economical and advantageous than farmer's local practice. Now again we advised the farmers to apply research recommended agronomic practice and other management system for better grain yield production of chickpea.

Acknowledgement

We would like to acknowledge, Wondo Genet Agricultural Research Center and crop research process for providing all the necessary facilities and support during the entire experimentation. We also extend our grateful thanks for Wereda Agricultural office, kebele development agent experts and farmers for their cooperation from the site selection to end of the study. Our acknowledgement also to Mr. Wukianos Erdachew of technical assistance for his tireless effort and collect all necessary data from all experimental fields during experimentation time

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