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Enhancing the productivity of groundnut (*Arachis hypogaea*) through earthening up practices at Tanqua-Abergelle district, Central Tigray, Ethiopia

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Groundnut, an important crop provides significant sources of cash, oil and an important role in diets but the yield is low due to different constraints like earthening up. In this regard, this study was carried out to improve yields by identifying the best stages of earthening up practices. The experiment was conducted at Abergelle Agricultural Research Centre testing site in 2010/2011 and 2011/2012 cropping seasons. The experiment was carried out in a randomized complete block design with three replications. There were seven treatments of earthening up (pre-flowering, 25% flowering stage, 50% flowering stage, 75% flowering stage, 50% pegging, pre-flowering + 50% flowering + 50% peg formation and control). The analyzed variables (days to 90% maturity, biomass yield, grain yield, harvest index, 1000 seed weight, number of pods/plant and number of seeds/pod) revealed significantly difference (p=5%). The analysis of variance showed that highest yield was obtained from 50% earthening up (23 ql/ha) and lowest grain yield was observed in control/no earthening up (18 qt/ha). Generally, earthening up practices at 50% flowering stage enhances the yield of groundnut. So, it should be practiced or applied at similar agro-ecology for better yield of ground nut.

Key words: Yield, yield components, groundnut, earthening up.

INTRODUCTION

The groundnut (Arachis hypogaea L.) is an important oilseed crop of the semi-arid tropics (Tarimo, 1997) that ranks thirteenth (13th) in importance among world crops (Hatam et al., 1994). It is a staple food in a number of developing countries much valued for its protein content and as source of income for small holder farmers. It is also a good source of edible oil for humans, as well as a nutritive feed supplement for livestock. Yields obtained from the crop are traditionally low due to a combination of factors including unreliable rains, little technology available to small scale farmers, pest and disease occurrences, poor seed technology and agronomic practices, as well as increased cultivation on marginal lands (Konlan et al., 2013).

Groundnut (*Arachis hypogaea* L.) is the 6th most important oil seed crop in the world. It contains 48-50% oil, 26 to 28% protein and 11 to 27% carbohydrate, minerals and vitamin (Mukhtar, 2009). Groundnut is grown on 26.4

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million hectare worldwide, with a total production of 37.1 million metric tons and an average productivity of 1.4 metric tons /ha. Developing countries constitute 97% of the global area and 94% of the global production of this crop (FAO, 2011). The production of groundnut is concentrated in Asia and Africa, where the crop is grown mostly by smallholder farmers under rain-fed conditions with limited inputs.

Among the several legumes, groundnut by far is the most important, usually grown as cash crop. The added benefit groundnut brings to the agricultural production systems through biological nitrogen fixation have been well studied and documented (Toomsan et al., 1995). Grain legumes like groundnut have been reported to provide an equivalent of 60 kg N ha^{-1} to subsequent non-legume crop (Ghosh, 2007). There have been several reports on increased production of cereal following groundnut in the crop sequence (Hedge and Dwivedi, 1993). It was reported that lower doses of N (20 kg N ha-1) fertilizer were required by sorghum following groundnut as compared to sorghum following cowpea (60 kg N ha^{-1}) to achieve the same yield results. Similarly, wheat which followed groundnut recorded higher grain yield than that following pearl millet (Bado et al., 2006). In a fodder legume experiment, the carry-over of N from groundnut for use by the succeeding crop was found to be 54-58 kg N ha^{-1} (Hedge et al., 1993). In legume/legume intercropping, practiced largely in India, the predominant intercropping system is pigeon pea/groundnut system found in most parts of dry land areas because of the ability of groundnut to establish rapid canopy cover over the ground and efficiently utilize growth resources (Ghosh, 2007). Groundnut included in the cropping system is known to help solubilize insoluble P in the soil, improve the soil physical environment, increase soil microbial activity, restore organic matter and smother weeds (Ghosh, 2007). Together with other factors; use of low plant population density per unit area is responsible for low yields in groundnut. Yayock (1979) reported that as much as 150 to 250% increase in pod yield can be expected by cropping at higher population densities and applying better management. Similarly, other researchers (Giri, 1986; Tanimu, 1998) have reported that it is possible to produce higher yields of groundnut by increasing plant population.

Groundnut is grown for its oil seed and grain legume, it is a major cash crop grown around the country and some areas of the Tigray region for direct use as food oil and high protein meal. Around Tanqua Abergelle area, groundnut is one of the crops widely grown in the area. It is better grown in sandy soils of poor fertility and low humus content. This is because it does not respond well to more fertile soils and well drained sandy loams with good structure are the most favorable for groundnuts by providing suitable environmental condition to penetrate the pegs easily which exactly fits the Tanqua Abergelle woreda. It has suitable agro-ecology for production of ground nut and the farmers grow it for various purposes. Groundnut needs many agronomic practices during production in order to get the maximum yield. Among them, earthening up is one of the major agronomic practices in groundnut production farms. This practice has significant effect on the productivity of groundnut. However, farmers in Tanqua Abergelle do not practice it. Thus, it is important to introduce and familiarize this practice for groundnut production in the area. The objective the study was to increase yield and yield components of groundnut through earthening up practices, to identify the best stage of earthening up of groundnut and to familiarize farmers with the practice of earthening up techniques.

MATERIALS AND METHODS

Description of the study area

The study area is located at Central Zone of Tigray which is 120 km far from Mekelle. The experiment was conducted in Abergelle Agricultural Research Center testing site. It is located 13°14’06”N Latitude and 38°58’50”E longitudes. It is agro-ecologically characterized as hot warm sub-moist low land (SMl-4b) below 1500 m.a.s.l. The mean annual rainfall is 350 to 700 mm and with minimum and maximum temperature is 24 and 41°C, respectively.

Experimental details

The experiment was conducted in Tanqua at Abergelle Agricultural Research Center testing site in a randomized complete block design with three replications having a plot size of 3 x 4 m (12 m^2) and the inter and intra row spacing was 60 and 20 cm, respectively (Ethiopia Agricultural Research Institute, 2004, Directory of released crop varieties). The spacing between blocks and plots was 100 and 50 cm, respectively. Groundnut variety, Sedi, was planted at a seed rate of 80 kg/ha. At planting, 100 kg/ha DAP was applied. The treatments included: Earthening up at pre flowering stage; earthening up at 25% flowering stage; earthening up at 50% flowering stage; earthening up at 75% flowering stage; earthening up at 50% pegging formation; earthening up at pre-flowering + 50% flowering + 50% pegging formation; Control or no earthening up.

Before and after planting, all the necessary agronomic practices were applied as per recommendation such as land preparation, spacing, fertilizer, weeding and hoeing.

Data collection

The following data were collected during the experiment. Days to 90% maturity; biomass yield (qt/ha); grain yield (qt/ha); harvest index; 1000 seed weight; number of pods/plant; number of seeds per pod.

Data analysis

The data that were collected during the season were analyzed using GenStat® (cairns, 2011. 13th edition). appropriate computer software program. The treatment means were separated using LSD test at 5% level of probability.

Table 1. Maturity date, number of pods per plant and grain yield of groundnut as affected by earthening up.

Treatments	Maturity date			Number of pods per plant			Grain yield (qt/ha)		
	Y-1	Y-2	Mean	Y-1	Y-2	Mean	Y-1	Y-2	Mean
Pre-flowering	105.3[bc]	93.7[c]	99	31.67[d]	30.7[ab]	31.2	25.53d	11.7[b]	19
At 25% flowering	122.7[a]	101.7[a]	112	52.33[a]	30[b]	41.2	30.76[a]	12.9[a]	22
At 50% flowering	125[a]	102.3[a]	113	52.67[a]	28.3[c]	40.5	31.91 [a]	13.5[a]	23
At75% flowering	118[ab]	98.3[b]	100	46[b]	31.7[a]	38.8	28.33[c]	11.5[b]	20
At50% pegging	130[a]	95.3[bc]	112	46[b]	30.3[ab]	38.1	28.46[c]	11.6[b]	20
Preflowering + 50% flowering + 50% peg formation	130[a]	102[a]	116	47.33[ab]	31.3[ab]	39.3	29.11[bc]	11.5[b]	20
Control	104[c]	96.7[bc]	100	38.67[c]	31.7[a]	35.2	24.84[d]	11.1[b]	18
CV (%)	5.72	1.67		5.48	5.34		3.21	4.62	
LSD(0.05)	13.64	3.29		6.02	1.66		1.82	1.14	
SE(±)	3.94	0.95		1.73	0.48		0.52	0.32	

Y-1 = year one; Y-2 = year two ; SE= standard error of mean

RESULT AND DISCUSSION

Days to maturity

A day to maturity is the day in which the varieties are 90% matured which are ready for harvesting. According to the data analysis of the 2010/2011 cropping season, there was statistically significant difference at p=5% among the different earthening up of ground nut in days to maturity (Table 1). The highest days to maturity were observed in the combined application of pre-flowering + 50% flowering + 50% peg formation and the lowest days to maturity were observed at control or no earthening up practices. On the same way, the analyzed data of the 2011/2012 cropping season showed that there was statistically significance difference among the varieties of groundnut at p=5% in days to maturity. In general, the cumulative average of the two cropping seasons, the highest days to maturity was recorded in the combined application pre-flowering + 50% flowering + 50% peg formation and the lowest days to maturity were observed in no earthening up practices. This difference may be due to the environmental condition during the earthening up application of the season. Earthening up at pre-flowering + 50% flowering + 50% peg formation conserves more moisture and this prolongs the maturity date of the crop.

Number of pods per plant

The analyzed data during 2010/2011 cropping season showed that there was statistically significant difference among the earthening up practices in pods per plant (Table 1). The highest and the lowest number of pods per plant were observed at 50% earthening practices and at pre-flowering stage which are 52.67 and 31.67 pods per plant, respectively. In 2011/2012 cropping season, the analyzed data indicated that there was statistically significance difference among earthening up of groundnut in pod number per plant. But, the highest and lowest number of pods per plant was shown in 75% flowering stage and 50% flowering stage which is 31.7 and 28.3 pods, respectively. The cumulative pod number per plant during the two cropping seasons showed that the highest and lowest pod number per plant was observed in earthening up of 50% flowering stage and pre-flowering stage which is 41.2 pod numbers per plant and 31.3 pod number/plant, respectively.

Grain yield

The analyzed data during 2010/2011 cropping season showed that there was statistically significant difference among the earthening up practices in grain yield (Table 1). The highest and the lowest number of grain yield were observed at 50% earthening practices and control which are 31.91 and 24.84 Qt/ha, respectively. In 2011/2012 cropping season, the analyzed data indicated that there was statistically significance difference among earthening up of groundnut in grain yield. But, the highest and lowest number of grain was shown in 50% flowering stage and control which is 13.5 and 11.10 Qt/ha, respectively. This yield reduction was due to the cropping season of 2011/2012 there was no adequate rain fall as compared to the 2010/2011 cropping season. The cumulative grain yield during the two cropping seasons showed that the highest and lowest grain yield was observed in 50% earthening up and control or no earthening which is 23 and 18 Qt/ha, respectively.

Biomass yield

Data presented in Table 2 revealed that at 25% stage

Table 2. Biomass yield, harvest index, number of seeds per pod and 1000 seed weight of groundnut as affected by earthening up practice.

S/N	Treatments	Biomass yield (qt/ha) (mean of Y-1 & Y-2)	Harvest index (mean of Y-1 & Y-2)	No. of seeds per pod (mean of Y-1 and Y-2)	1000 seed weight (g) (mean of Y-1 and Y-2)
1	Pre-flowering	36	0.56	3	0.387
2	At25% flowering	54	0.55	3	0.407
3	At50% flowering	44	0.56	4	0.413
4	At75% flowering	39	0.59	4	0.377
5	At50% pegging	39	0.58	4	0.373
6	Preflowering+50%flowering+50% peg formation	39	0.59	4	0.373
7	Control	36	0.55	2	0.37
	CV (%)	7	9.95	6.09	6.39
	LSD (0.05)	6.35	0.11	0.52	0.06
	SE(±)	1.8	3.32	0.15	0.01

Y-1 = Year one; Y-2 = year two; SE= standard error of mean.

and at 50% flowering stage, highest significant (p=0.05) biomass yield (56.66Qt/ha and 56.67Qt/ha) was produced in the first cropping season. On the other hand, the lowest biomass yield was recorded in pre-flowering which is 27 Qt/ha. In the second cropping season, there was statistically significant difference in biomass yield of the different earthening up stages. The highest and lowest biomass yield was observed in 25% earthening up stage and both in the control or no earthening up practices and pre-flowering stages which is 52.2 and 36 Qt/ha, respectively. The cumulative average of the two cropping seasons showed that the highest and lowest biomass yield was observed in 25% earthening up practice and equally in control and pre-flowering earthening up practices which is 54 and 36 Qt/ha, respectively.

Number of seeds per pod

The analyzed data (Table 2) showed that there was statistically significant difference in number of seeds per pod among the different earthening up stages. Thus, the highest and lowest number of seeds per pod was recorded in pre-flowering + 50% flowering + 50% peg formation and control which is 3.60 seeds and 2.87 seeds per pod, respectively.

Harvest index

The analyzed data showed that there was no statistically significance difference in harvest index among the different stages of earthening up. However, the highest and lowest harvest index was observed to be equally at both 75% flowering earthening up and pre-flowering + 50% flowering + 50% peg formation and both equally at 25% flowering and control which is 0.59 and 0.55, respectively.

1000 seed weight (gm)

The analyzed data showed that there was no statistically significance difference in thousand seed weight among the different stages of earthening up. However, the highest and lowest thousand seed weight was observed at 50% flowering earthening up practices which is 0.413 and 0.37 g, respectively (Table 2).

Conclusions

The analyzed data indicated that there was statistically significant difference in yield and yield components of the treatments. The highest yield was obtained from the earthning up at 50% flowering stage than the other treatments (Table 1). The variation in yield may due to earthning up at 50% flowering which is critical to Arial pegs developing into pods without waste, and may be converted into productive pods with good seed filling. Those in which earthning up was performed had maximum yield as compared to the control, that is, no earthening up was done. This may also indicate earthening up at 50% flowering stage initiates the pegs changing to pod. So, earthening up of groundnut at 50% flowering stage enhanced 5 Qt/ha yield advantage as compared to control/no earthening up. Therefore, farmers should apply these practices and should be scaled out to other groundnut potential areas with similar agro-ecology like the study area.

Conflict of interest

The authors have not declared any conflict of interest.

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