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Correlation and regression studies of wheat-weed under *Eucalyptus tereticornis* based agroforestry system

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Abstract
Eucalyptus tereticornis (family – Myrtaceae) is highly use full and important species in commercial forestry due to fast growing and short rotation period. The present investigation was conducted in *Eucalyptus tereticornis* and wheat based agroforestry system with different weed control methods to find out correlation of wheat yield with various growth characters and weed density under agroforestry system. In experiment plot 5 major weeds *Phalaris minor*, *Rumex dentatus*, *Chenopodium album*, *Launaea nudicaulis* and *Melilotus indica* was found with wheat crop. The correlation analysis revealed that *Phalaris minor* had highest negative association with grain yield (-0.731 and -0.795) during both the year. Regression analysis revealed that the reduction in yield could be to extent of 0.61 q/ha with increase of one plant of *Launaea nudicaulis* during both year. *Rumex dentatus* reduced highest extent of grain yield (0.58 q/ha) with add a single plant. The degree of association of different yield association parameter with yield of grain indicate that length of panicles had highest positive correlation (0.992 and 0.982) amongst different production increasing parameter followed by 1000 grain weight (0.993 and 0.980), leaf area index (0.986 and 0.960), number of effective tillers (0.889 and 0.939) and plant height (0.883 and 0.926) during both the year. The yield was increasing predicted with index of leaf area, height of plant, effective tillers, panicles length, and weight of 1000 grain during both the year. The production was increase with 14.36 and 14.25, 0.73 and 0.64, 0.37 and 0.34, 2.60 and 2.42, 0.75 and 0.90 q/ha during both the year under this agroforestry system.

Keywords: *Eucalyptus tereticornis*, wheat, weed, correlation, regression

Introduction
Agroforestry is ideal land use option to increase its productivity, expand perennial woody cover outside forest area and minimize anthropogenic load on natural forests. It is also viable option for mitigation of climate change. Many agroforsetry system involving various combination of woody perennials and agriculture crops have been evolved and successfully tried in field with increased economic and ecological benefits. Eucalyptus based agroforestry system are also popular agroforestry model.

Eucalyptus is a tree which have rapid growth and serving pulp and paper industry and bioenergy. Eucalyptus is highly acceptable plant by farmer planted in bunds and edges due to low canopy area and incorporated with agroforestry in India (Cavalli *et al.* 2022, Nair, PKR.1993, Tejwani, KG, 1993) [2, 8, 12]. Despite of its adaptability to different agro-climatic condition, is monoculture may be somewhat risk prone. Intercropping of suitable agriculture crop with *E. tereticornis* can there for be a better option as it not only reduces the economic risks associated with monoculture by generating extra income but it also result in increased production and systematic usage of solar energy and available soil nutrient.

A number of agriculture crop have been tried in combination with eucalyptus and wheat one of them. Wheat is a well grown under eucalyptus tree and it is also the main crop in Madhya Pradesh. It is an important food worldwide. Wheat is growing with eucalyptus, poplar and other fast growing trees at rabi season (November to April) in northern Indian states.

Weeds are unwanted plants in crop area that interfere with different crops and cause adverse effect on the crops. Weed infestation is an important factor limiting crop yield and production. Weeds not only reduce yield but they also make harvesting difficult for this reason good management is very important in order to control food production and food safety. It has been different experiments reported that uncontrolled weed cause 66% decrease in wheat grain yield (Dixit and Singh, 2008) [3].

Present investigation has been undertaken during 2016-17 and 2017-18 to study the relation of different growth and yield / production increasing character in wheat crop and weed infestation

and management practices under wheat weed ecosystem with eucalyptus based agroforestry system.

Materials and Methods

The field experiment was organised at farmer's field of district Jabalpur under the guidance of department of Forestry JNKVV Jabalpur during *Rabi* season of 2016 -2017 and 2017-2018 two year experiment. The experiment is conducted with 3 replication and 10 weed control treatments in wheat crop intercropped with eucalyptus tree.

Data collection and statistical analysis

The investigation finding out association among various growth characters, *viz*, plant height, leaf area index, number of effective tillers, length of penicles, 1000 grain weight (g) and weed density on wheat production under agroforestry system.

Analysis of interdependence and correlation among different growth parameter is an important aspect of variation and selection studies. During the present investigation correlation and regression analysis among the various variable was done using the standard procedure Sendecor and Cochran (1967) [11].

The correlation and regression studies aimed at understanding the relationship between different growth characters in biological system. In such biological system each variable influences the other variables. Ordinarily in a simple statistical analysis variable are classified into predictor (independent) and criterion (dependent) variables. A predictor variable is used to predict an outcome and the criterion variable are also called response variable.

During the present investigation the data on various character and weed density are collected and statistical analyse. A matrix of correlation in table sowing correlation coefficient between a variables sets. Each random variable in the table correlate each other values in the table. This allows one to be see witch pairs have the highest correlation. The diagonal of the table is always a set in once because the relation between a variable and itself is always 1.

The various crop growth characters and correlation matrix of crop yield was calculated by Sendecor and Cochran (1967) [11] suggested formula.

$$r = \frac{\sum XY - \frac{\sum X \sum Y}{N}}{\sqrt{\left(\sum X^2 - \frac{(\sum X)^2}{N}\right)\left(\sum Y^2 - \frac{(\sum Y)^2}{N}\right)}}$$

In order to predict the effects of weeds on crop yield regression models and correlation coefficients were used account of various variable crop yield. This regression equation was used

$$\hat{Y} = a + bX$$

Where,

$\hat{Y}$ = wheat yield or standard out come

X = weed density/ independent variable

a and b are constant of regression and coefficient of regression, respectively.

Results and Discussion

Correlation of weed density with grain yield

The correlation amongst weed density of different species with total grain yield production was found negative association and significant (Table 01). The correlation analysis revealed that *Phalaris minor* had highest negative association with grain yield (-0.731 and -0.795) during both the year.

Regression (weed density with grain yield)

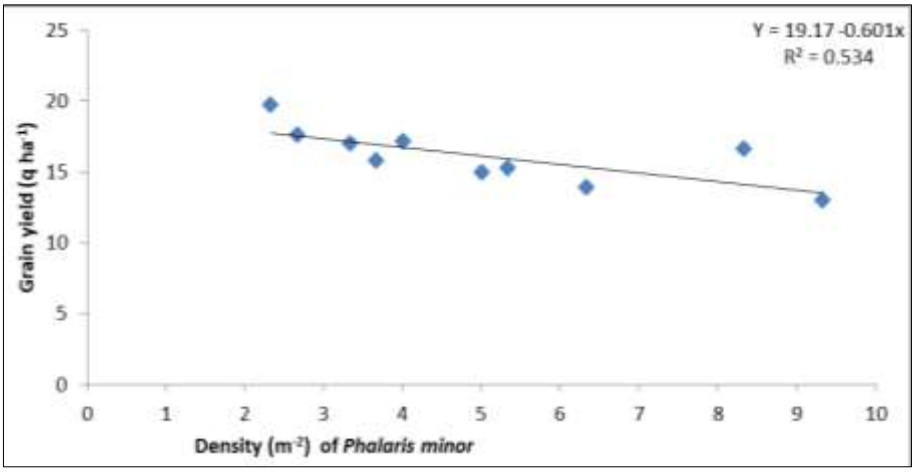
The regression analysis (Table 2) revealed that the reduction in yield could be to extent of 0.61 q/ha with increase of one plant of *launaea nudicaulis*. The greater reduction yield can also be recorded due to density of *Phalaris minor*, *Rumex dentatus*, *Chenopodium album*, and *Melilotus indicus*. The reduction could be predicted by 0.60, 0.58, 0.51 and 0.48 q/ha respectively during first year of experiment (2016-17). However, during second year of experiment (2017-18) *Rumex dentatus* reduced highest extent of grain yield (0.58 q/ha) with increase of one plant followed by *Launaea nudicaulis*, *Chenopodium album*, *Phalaris minor*, *Melilotus indicus*. The reduction could be predicted by 0.56, 0.46, 0.45 and 0.44 q/ha with increase of one plant of weed species, respectively. The best fit regression equation have also been depicted in Fig. 1-2.

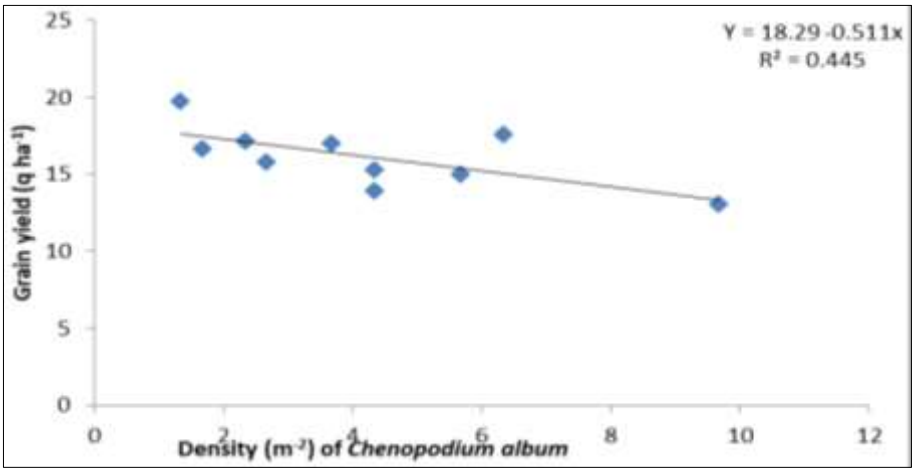
Table 1: Correlation between weed density (m^{-2}) and grain yield (q/ha)

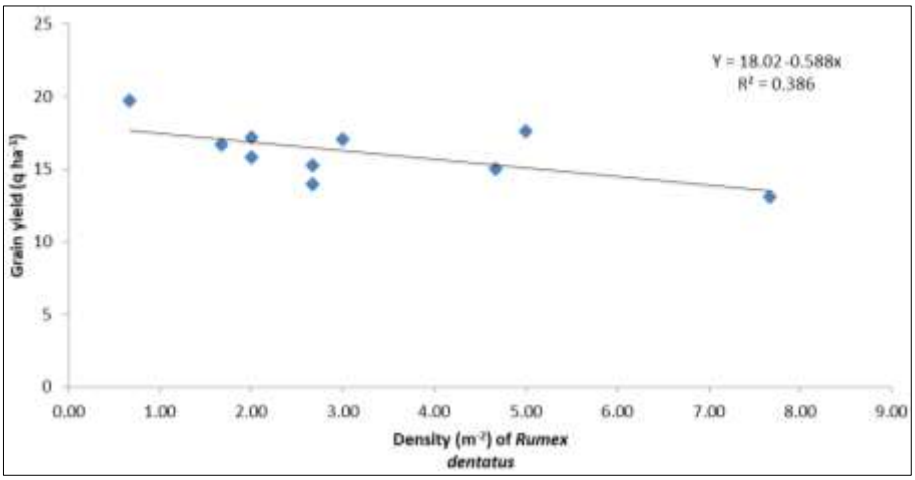
Character	Chenopodium album	Rumex dentatus	Launaea nudicaulis	Melilotus indicus	Total weed	Grain yield (q/ha)
	X_2	X_3	X_4	X_5	X_6	Y
First year (2016-17)						
X_1- Phalaris minor	0.429^{NS}	0.441^{NS}	0.606^{NS}	0.591^{NS}	0.609^{NS}	-0.731^{*}
X_2- Chenopodium album		0.982^{**}	0.910^{**}	0.941^{**}	0.960^{**}	-0.668^{*}
X_3- Rumex dentatus			0.877^{**}	0.927^{**}	0.951^{**}	-0.621^{NS}
X_4- Launaea nudicaulis				0.975^{**}	0.975^{**}	-0.700^{*}
X_5- Melilotus indicus					0.980^{**}	-0.698^{*}
X_6- Total weed						-0.708^{*}
Second year (2017-18)						
Character	X_2	X_3	X_4	X_5	X_6	Y
X_1- Phalaris minor	0.738^{*}	0.809^{**}	0.804^{**}	0.831^{**}	0.828^{**}	-0.795^{**}
X_2- Chenopodium album		0.968^{**}	0.961^{**}	0.970^{**}	0.987^{**}	-0.714^{*}
X_3- Rumex dentatus			0.937^{**}	0.974^{**}	0.981^{**}	-0.731^{*}
X_4- Launaea nudicaulis				0.968^{**}	0.979^{**}	-0.742^{*}
X_5- Melilotus indicus					0.989^{**}	-0.686^{*}
X_6- Total weed						-0.747^{*}

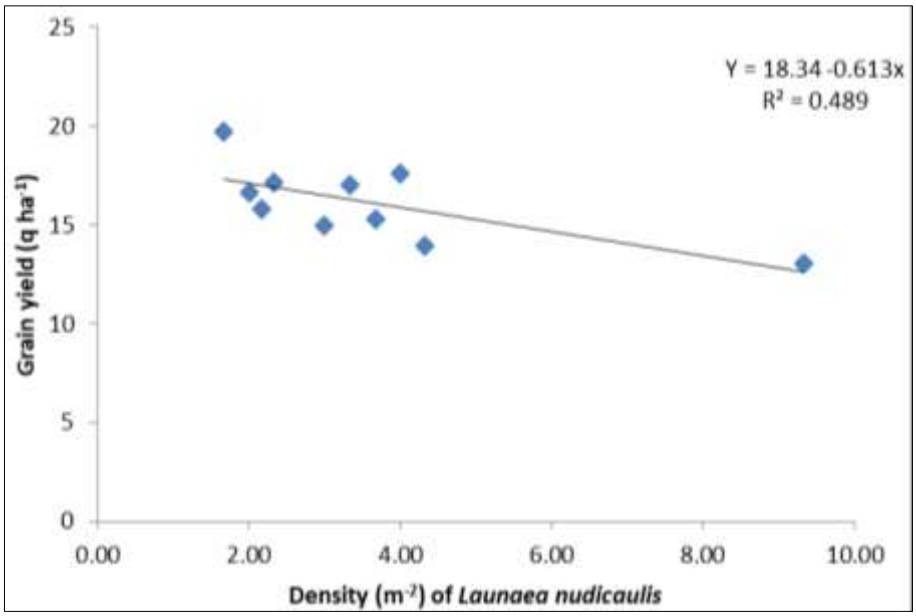
Table 2: Regression between weed density with yield of grain (q/ha)

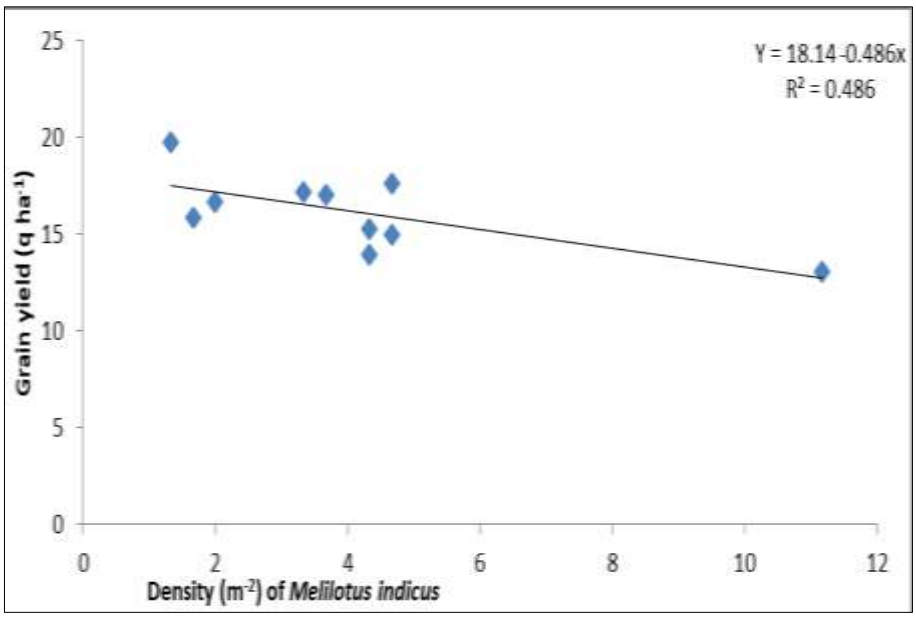
Character	$\hat{Y}$= a + bx	R^2
First year (2016-17)		
X_1- Phalaris minor	$\hat{Y}$ = 19.17 - 0.601 X_1	R^2 = 0.534
X_2- Chenopodium album	$\hat{Y}$ =18.29 - 0.511 X_2	R^2 = 0.445
X_3- Rumex dentatus	$\hat{Y}$ =18.02 - 0.588 X_3	R^2 = 0.386
X_4- Launaea nudicaulis	$\hat{Y}$ = 18.34 - 0.613 X_4	R^2 = 0.489
X_5- Melilotus indicus	$\hat{Y}$ = 18.14 - 0.486 X_5	R^2 = 0.486
X_6- Total weed	$\hat{Y}$ =-19.89 - 0.181 X_6	R^2 = 0.501
Second year (2017-18)		
X_1- Phalaris minor	$\hat{Y}$ =16.82 - 0.453 X_1	R^2 = 0.631
X_2- Chenopodium album	$\hat{Y}$ = 16.61 - 0.461 X_2	R^2 = 0.509
X_3- Rumex dentatus	$\hat{Y}$ = 16.52 - 0.58 X_3	R^2 = 0.534
X_4- Launaea nudicaulis	$\hat{Y}$ =16.61 - 0.561 X_4	R^2 = 0.550
X_5- Melilotus indicus	$\hat{Y}$ = 16.35 - 0.446 X_5	R^2 = 0.470
X_6- Total weed	$\hat{Y}$ =18.08 - 0.183 X_6	R^2 = 0.557











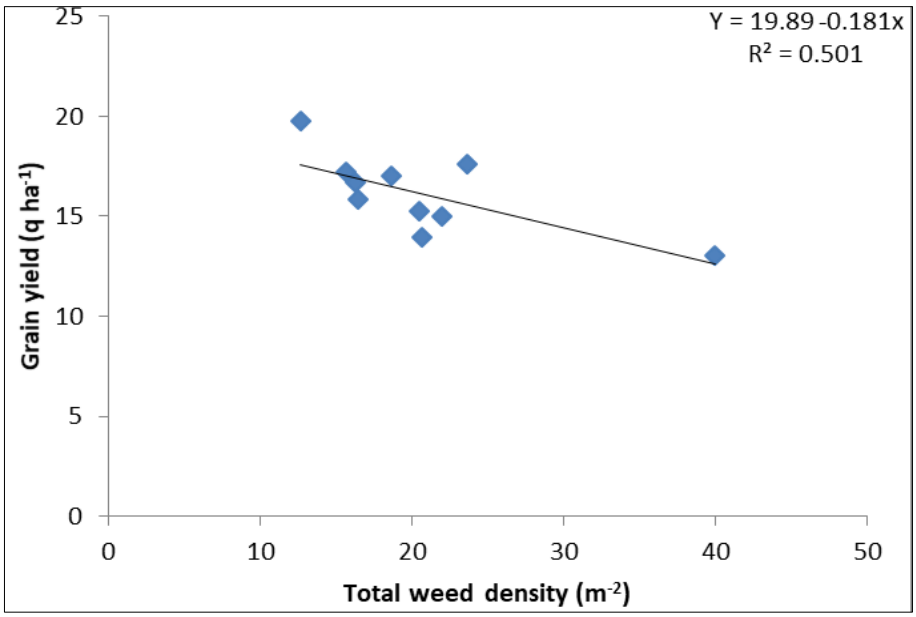
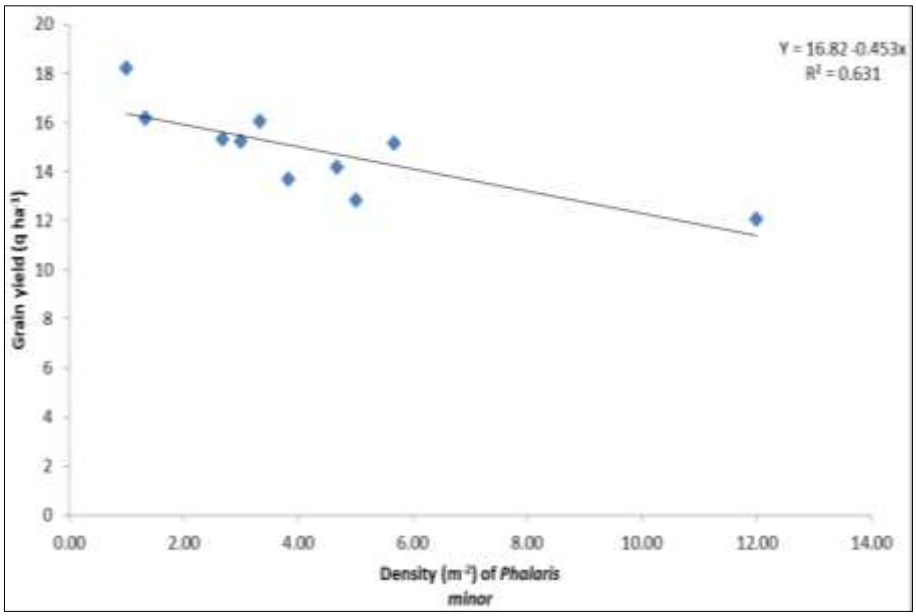
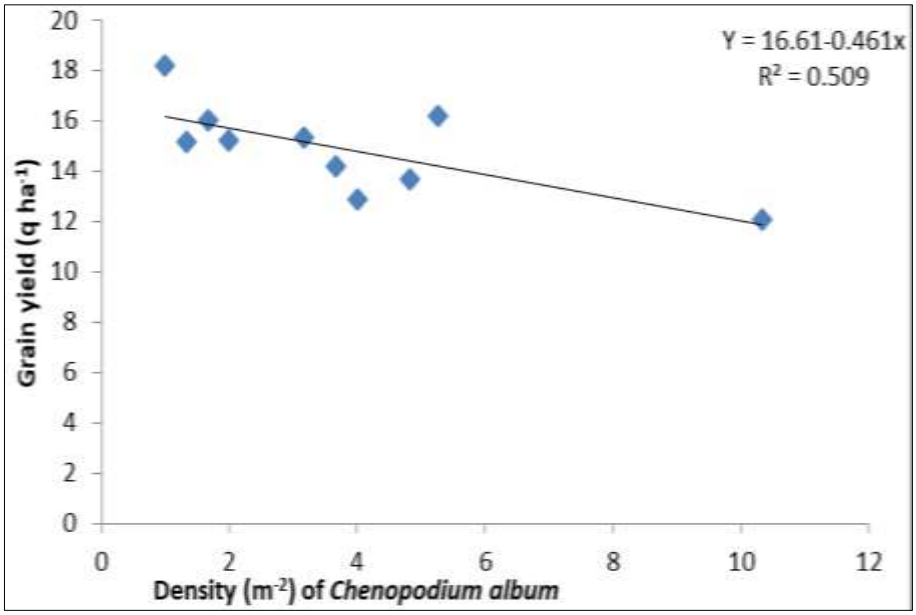
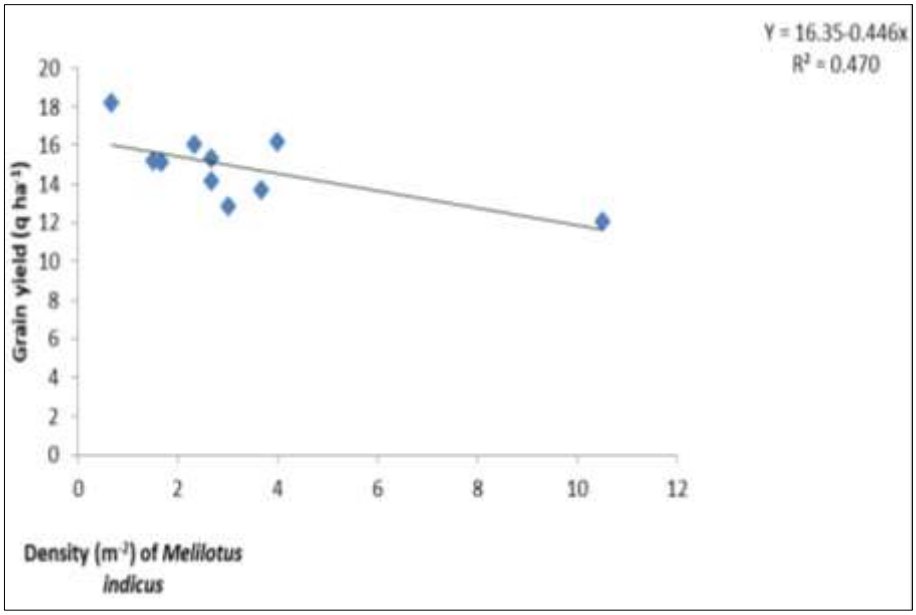


Fig 1: Regression of weed density (m^{-2}) of different species on grain yield (q/ha) during first year (2016-17)


Y = 16.82 -0.453x
R² = 0.631
Grain yield (q ha⁻¹)
Density (m⁻²) of Phalaris minor


Y = 16.61-0.461x
R² = 0.509
Grain yield (q ha⁻¹)
Density (m⁻²) of Chenopodium album


Y = 16.35-0.446x
R² = 0.470
Grain yield (q ha⁻¹)
Density (m⁻²) of Melilotus indicus

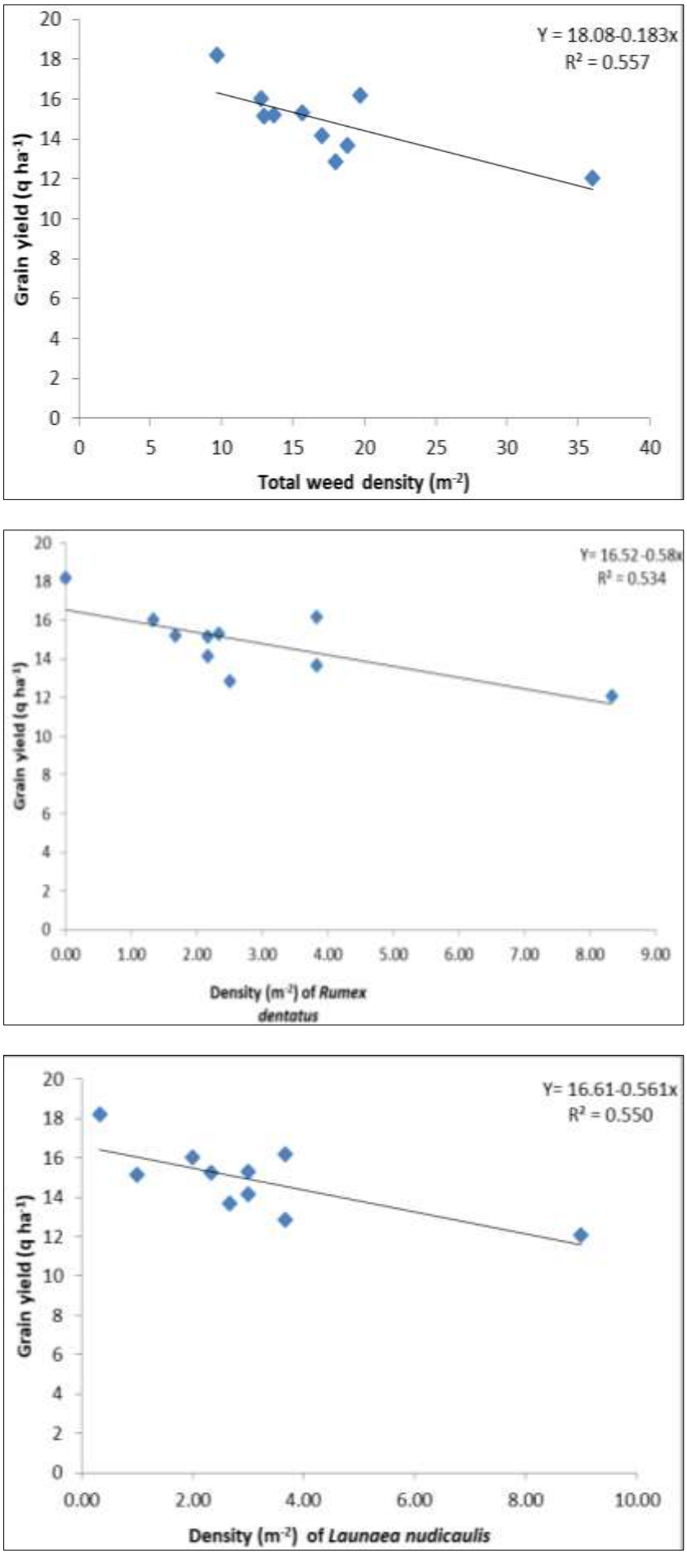


Fig 2: Regression of weed density (m-2) of different species on grain yield (q/ha) during second year (2017-18)

Correlation of production increasing parameter with grain yield

The different production increasing parameters with grain yield have positive association during 2016-17 and 2017-18 experimental year (Table 3).The different production increasing parameters with yield of grain cluied that length of panicles had highest positive correlation (0.992 and 0.982) amongst different production increasing parameter followed by 1000 grain weight (0.993 and 0.980), LAI (0.986 and 0.960) number of effective tillers (0.889 and 0.939) and plant height (0.883 and 0.926) during both the year. Jain *et al.* (2011) [4] also showed same finding.

Regression of production increasing parameter with grain yield

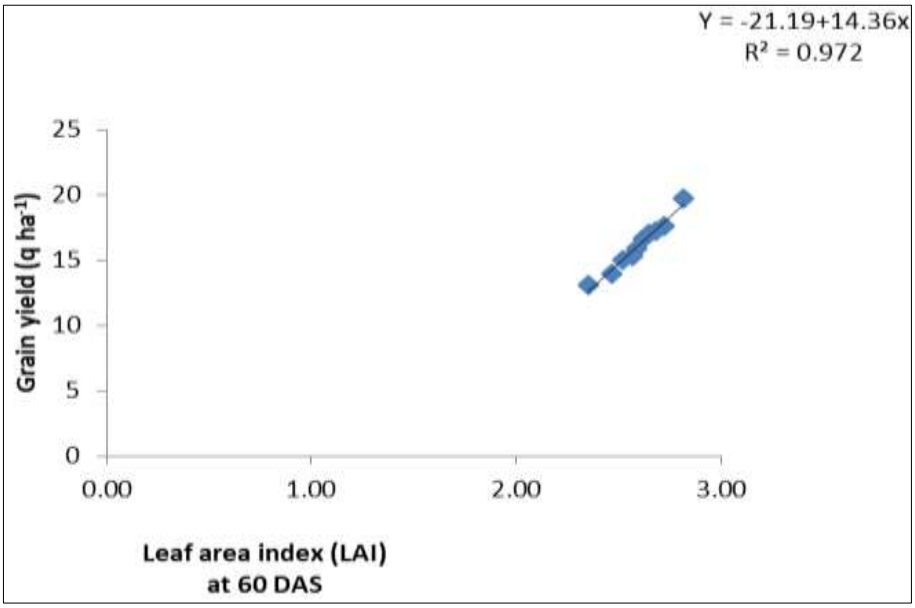
Amongst different production increasing parameters, the higher yield was predicted with index of leaf area, height of plant, effective tillers number, panicles length, and test weight grain weight during both the year (Table 4) (Fig.3-4).The higher yield could be predicted by14.36 and 14.25, 0.73 and 0.64, 0.37 and 0.34, 2.60 and 2.42, 0.75 and 0.90 during two year of experiment under wheat- *Eucalyptus tereticornis* based agroforestry system. The type findings are mentioned by Jain *et al.* (2011) [4] and Sarvade *et al.* (2014) [10].

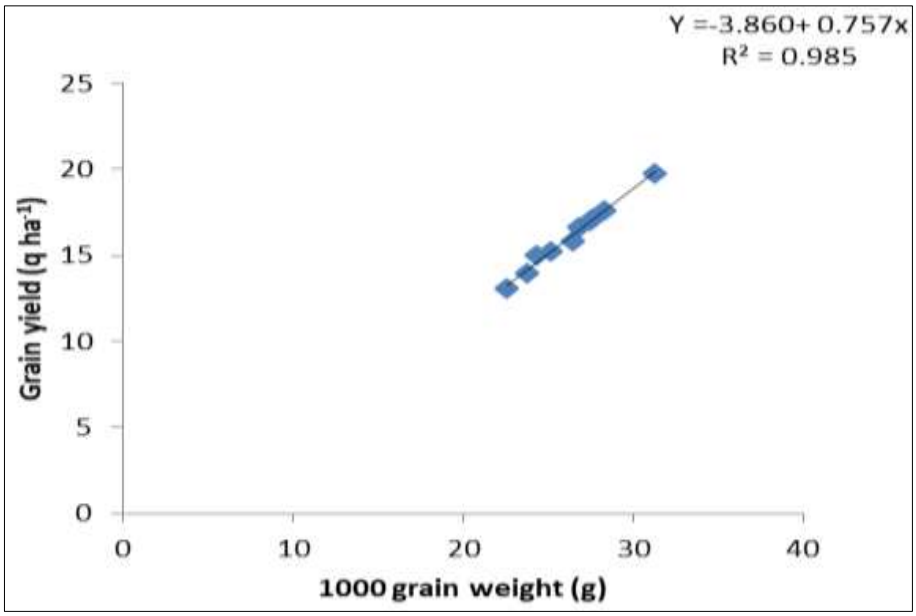
Table 3: Correlation between production increasing parameter with yield of grain (q/ha)

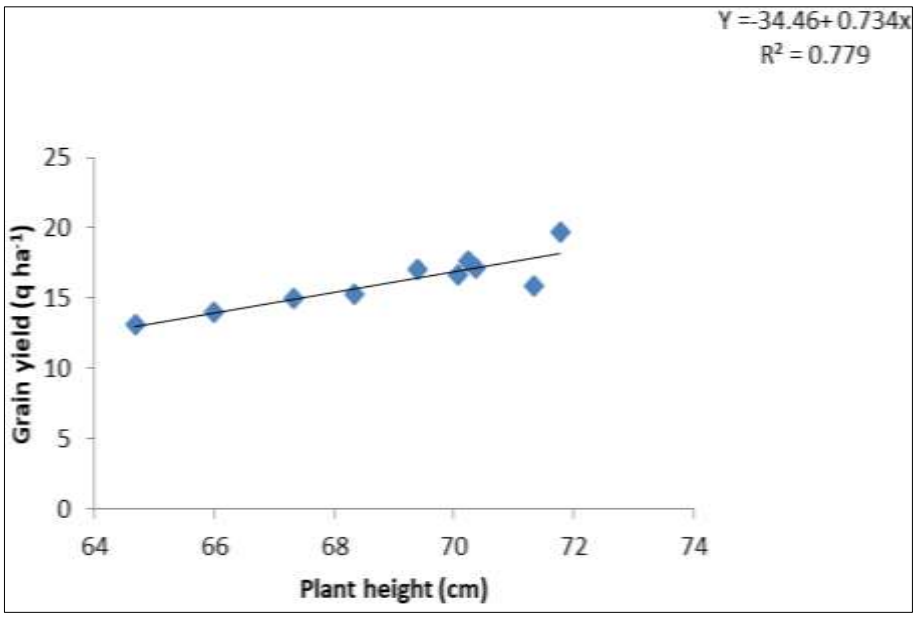
Character	Plant height (cm)	Effective tillers /MRL	Length of panicles (cm)	1000 grain weight (g)	Grain yield (q/ha)
	X_2	X_3	X_4	X_5	Y
First year (2016-17)					
X_1- LAI	0.902**	0.909**	0.980**	0.978**	0.986**
X_2- Plant height (cm)		0.856**	0.873**	0.891**	0.883**
X_3- Effective tillers /MRL			0.912**	0.912**	0.889**
X_4- Length of panicles (cm)				0.996**	0.992**
X_5- 1000 grain weight (g)					0.993**
Second year (2017-18)					
Character	X_2	X_3	X_4	X_5	Y
X_1- LAI	0.965**	0.965**	0.956**	0.939**	0.960**
X_2- Plant height (cm)		0.948**	0.898**	0.871**	0.926**
X_3- Effective tillers /MRL			0.939**	0.923**	0.939**
X_4- Length of panicles (cm)				0.992**	0.982**
X_5- 1000 grain weight (g)					0.980**

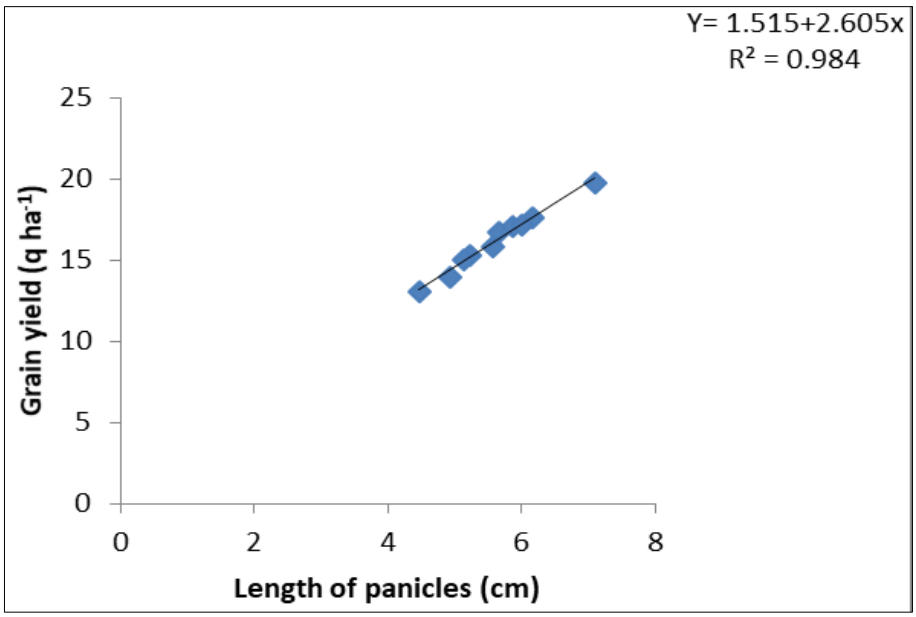
Table 4: Regression between production increasing parameter with yield of grain (q/ha)

Character	$\hat{Y}$= a + bx	R^2
First year (2016-17)		
X_1- LAI	$\hat{Y}$ = -21.19 + 14.36 X_1	R^2 = 0.972
X_2- Plant height (cm)	$\hat{Y}$ = -34.46 + 0.734 X_2	R^2 = 0.779
X_3- Effective tillers /MRL	$\hat{Y}$ = - 8.972 + 0.372 X_3	R^2 = 0.790
X_4- Length of panicles (cm)	$\hat{Y}$ = 1.515 + 2.605 X_4	R^2 = 0.984
X_5- 1000 grain weight (g)	$\hat{Y}$ = -3.860 + 0.757 X_5	R^2 = 0.985
Second year (2017-18)		
X_1- LAI	$\hat{Y}$ = -21.66 + 14.25 X_1	R^2 = 0.921
X_2- Plant height (cm)	$\hat{Y}$ = -28.74 + 0.642 X_2	R^2 = 0.857
X_3- Effective tillers /MRL	$\hat{Y}$ = -7.082 + 0.348 X_3	R^2 = 0.882
X_4- Length of panicles (cm)	$\hat{Y}$ = 2.586 + 2.420 X_4	R^2 = 0.964
X_5- 1000 grain weight (g)	$\hat{Y}$ = -7.280 + 0.900 X_5	R^2 = 0.959




Y =-3.860+ 0.757x
R² = 0.985
Grain yield (q ha-1)
25
20
15
10
5
0
0
10
20
30
40
1000 grain weight (g)


Y =-34.46+ 0.734x
R² = 0.779
Grain yield (q ha-1)
25
20
15
10
5
0
64
66
68
70
72
74
Plant height (cm)


Y= 1.515+2.605x
R² = 0.984
Grain yield (q ha-1)
25
20
15
10
5
0
0
2
4
6
8
Length of panicles (cm)

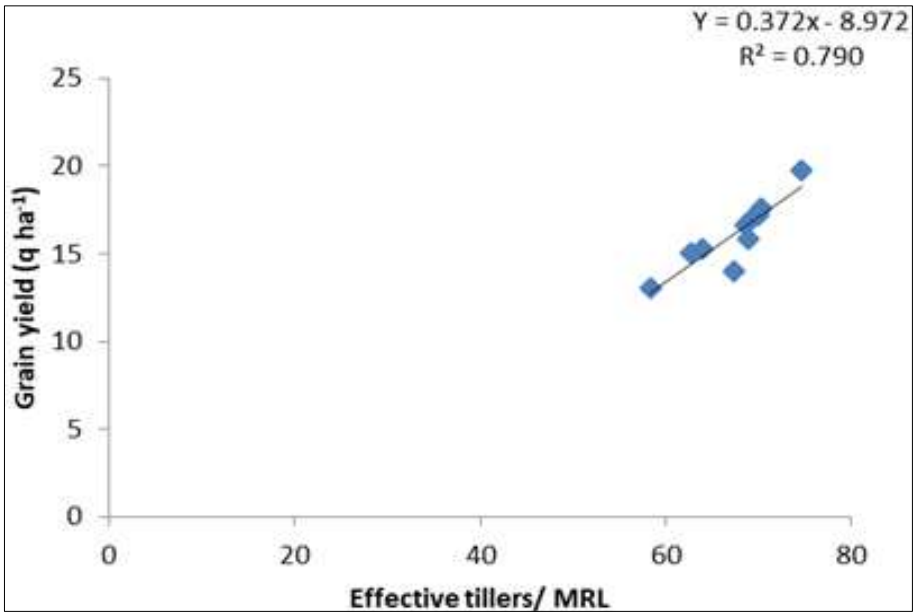
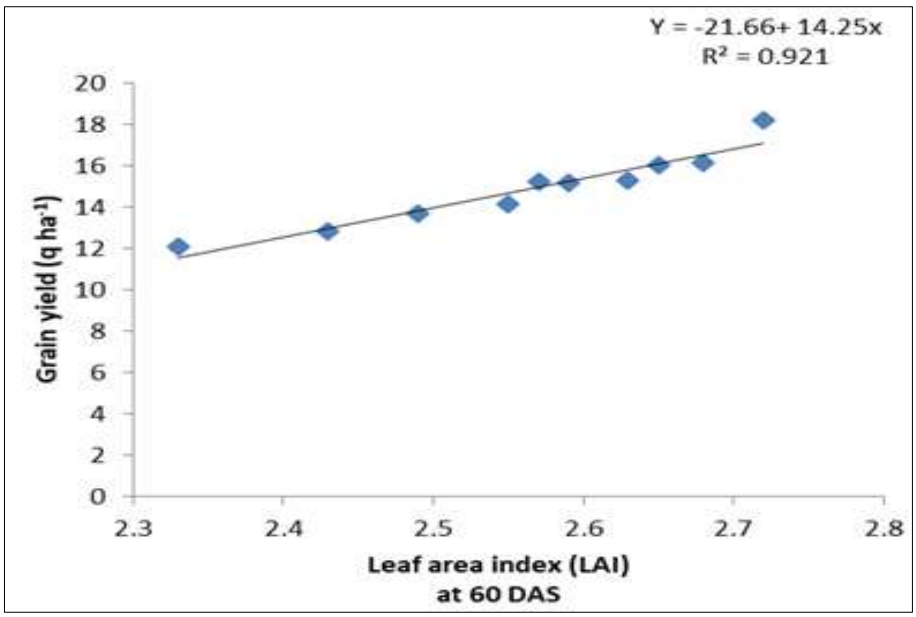
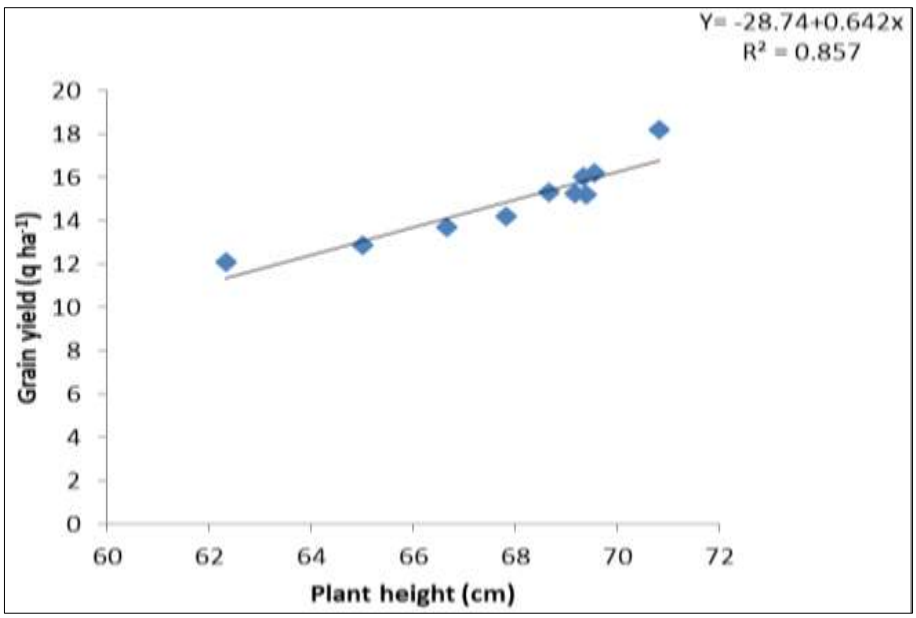


Fig 3: Regression of production increasing parameter on yield of grain (q/ha) during first year (2016-17)





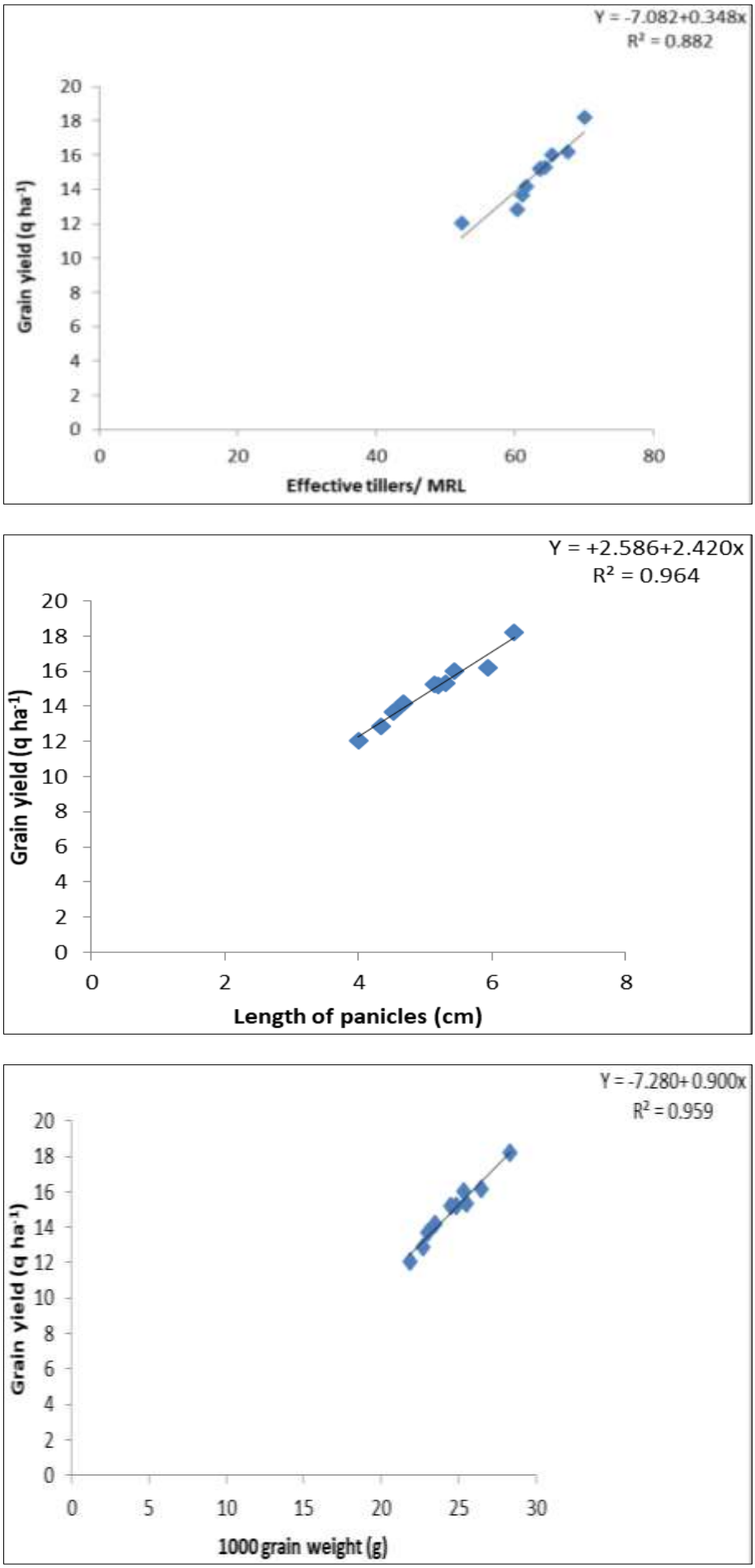


Fig 4: Regression of production increasing parameter on yield of grain (q/ha) during second year (2017-18)

Conclusion

It can be concluded from the forgoing analysis that weed density was negative association with grain yield. Phalaris minor have highly negative association among all weed it was attributed to that the different weeds caused the stress on crop growth and yield. The regression analysis revealed that the reduction in yield could be increase of one plant of *launaea nudicaulis and Rumex dentatus during both the year*. The greater reduction yield can also be recorded due to density of *Phalaris minor*, *Rumex dentatus*, *Chenopodium album*, and *Melilotus indicus*. It means the weeds are reducing the crop yield. The production increasing traits with yield of grain had positive correlation seen during both of the experimental year among production increasing parameters length of panicles had highest positive correlation than the 1000 grain weight, number of effective tillers and plant height during both the year. Amongst different production increasing traits, are increase the production was predicted by index of leaf area, height of plant, effective tillers, panicle length, and test weight during both the year of experiment under wheat-*Eucalyptus tereticornis* based agroforestry system.

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