

STUDIES ON INDEX DETERMINATION OF SOME TRITICALE GENOTYPES (*X Triticosecale* Witt.) NORMALIZED DIFFERENCE VEGETATION UNDER KONYA RAINFED CONDITIONS

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This study was conducted to determine the interactions between yield and normalized difference vegetation index (NDVI) of some triticale genotypes under Konya rainfed conditions. In this study, 22 lines and 3 varieties (Tatlıcak-97, Alperbey & Ozer) were used as plant material. The trial was set up according to Randomized Block Design with 3 replications at two locations of Bahri Dağdaş International Agricultural Research Institute rainfed experimental field and Konya province Sarayönü district in Gözlu location during 2018. NDVI values were recorded by a green scanner at two periods; end of tillering (Z-30) and end of stem elongation (Z-39). In terms of the highest values, TBVD-18 has 0.56 at Z-39 period and TBVD-3 and TBVD-9 lines were with 0.71 at Z-30. Regarding grain yield evaluation, the highest value was determined as TBVD-19 with 4.184 kg ha⁻¹ and Tatlıcak-97 with 3.511 kg ha⁻¹. At both stages the statistical relationships between grain yield and NDVI values were determined as important and positive.

Keywords: Triticale, Yield, NDVI, Genotypes, LSD.

INTRODUCTION

Triticale (*X Triticosecale* Wittmack) is a cool climate grain obtained by spontaneous hybridization of rye with wheat. The aim of wheat x rye is hybridization of high yield potential and quality of the intended target wheat rye in the stresses and diseases of scratching resistance in a single plant.

For this reason, triticale is more productive than other grain types, and an alternative crop especially in low annual precipitation and without irrigation possibilities of arid conditions. It can be cultivated successfully on marginal lands (Bağcı and Kan, 2016). The breeding activities have been carried out in recent years with the objective to determine the physiological properties that contribute to the yield and quality by combining the traditional breeding methods.

For determination of these physiological properties SPAD meter, thermal camera, NDVI (greenseeker) and leaf area index are used, which are fast, simple, inexpensive and can make measurements without damaging the plant.

The main objectives in breeding studies have been to improve the efficiency and quality characteristics. In the world, wheat yield has been increased by 60% during the last 30-35 years because of breeding new high yield potential varieties and 40% is a reflection of developments in cultural practices (Ruth *et al.*, 1984; Balla *et al.*, 1987).

Many observations, measurements and methods are used in determining the differences in breeding studies. These methods must be effective, sustainable, reliable, safe and time-saving and easy to application. Remote sensing methods are developed for these purposes and are an important

component of sensitive agricultural applications. These systems for monitoring plant growth, plant biomass, leaf area index (LAI), nitrogen (N) content and grain yield estimates are fast and non-destructive (Gamon *et al.*, 1995; Aparicio *et al.*, 2000; Cabrera-Bosquet *et al.*, 2011).

NDVI (Normalized Differential Vegetation Index) allows the areas with a high leaf density to be separated from the areas with relatively few leaves due to the chlorophyll's ability to reflect near infrared energy and to absorb red light (Kandemir, 2010). At the same time NDVI is the most widely used vegetation index (Sobrino and Raissoini, 2000), which proved to be quite successful in vegetation change, vegetation classification and calculation of some parameters.

Alternatively, vegetation indices derived from remotely sensed imagery can serve as a surrogate for plant biomass, to identify variation at both sub-field and regional scales (Mulla, 2013). The Normalized Difference Vegetation Index (NDVI) (Tucker, 1979) is the most widely used spectral index to estimate crop yield (Moriondo *et al.*, 2007). Many studies have reported strong correlations of NDVI with crop yield, particularly during the flowering and grain-filling period (Labus *et al.*, 2002; Mkhabela *et al.*, 2011). This correlation typically increases when multiple observations of NDVI are integrated across a period of growth (Benedetti and Rossini, 1993; Labus *et al.*, 2002).

The results obtained by proportioning the normalized difference vegetation index values or the near infrared band to the red band are used to determine whether the plant is weak, or empty space, as well as information about the green vegetation.

It would not be enough to explain the two-dimensional projection of vegetation canopy with the reflection of a single leaf used for many observations. When evaluated in this context, it can be said that the NDVI values obtained from the plant canopy of a complex structure composed of mosaic of many leaves, other plant structures, soil structure and shade are quite satisfactory.

Marti *et al.* (2017) studied six wheat varieties from tillering to milky stage at different times. The NDVI readings made a relationship between the beginning of elongation NDVI readings with biomass and yield, and at milky stage a positive relationship was determined with biomass and yield.

Kaya *et al.* (2008) conducted a study in Konya in order to estimate the early spring development with 20 varieties from cool climates of cereals (bread and durum wheat, barley, triticale) with the corrected vegetation coefficient difference (NDVI) and used the criterion of indirect selection. In the Zadoks 23 period, they determined the early fresh soil weight and NDVI values (0.88 ± 0.04 and 0.94 ± 0.02 , respectively) with high degree of heritability (H) and significant genetic ($r_g = 0.92 \pm 0.05$) and phenotypic ($r_p = 0.84 \pm 0.05$) relationship coefficients. Therefore, NDVI can be used to predict the early spring development as an indirect selection criterion.

The aim of this study was to investigate the relationship between the yield of NDVI data and the Triticale grain yield based on physiological parameters that could be integrated as an auxiliary instrument in classical breeding methods.

MATERIALS AND METHODS

The experimental trials were conducted at two different locations: Konya Bahri Dağdaş International Agricultural Research Institute (BDIARI) and Konya Sarayönü Gözlü TIGEM dry test areas during 2018 growing season. Twenty two lines and three standard types (Tatlicak-97, Alperbey and Ozer) were used as material in this study.

Konya's long term precipitation is around 310,6 mm and the average temperature is 20.1°C. During the vegetation period, precipitation at Konya-Merkez and Konya-Gözlü area (2017 October-2018 July) was recorded as 288.2 mm and 350.5 mm, respectively and the average temperature was 20.2°C and 20.6°C, respectively.

Konya-Central location of the trial land has a clayey structure (0-30 cm). The organic matter content was moderate (2.28%) and the lime content was very high (29.26%) and slightly alkaline (pH 7.82). While the amount of phosphorus (4.64 mg/kg P₂O₅) was found to be rich, the amount of potassium (92.31 mg/kg K₂O) was very high in terms of zinc content (0.262 mg/kg). There was no salinity (272 dS/m) problem in the soil of the trial fields (Parlak *et al.*, 2008).

The 0-30 cm layer of the Konya-Gözlü trial site has a clayey-tin structure. The organic matter content was low (1.25%) and it showed a calcified (1.52%) and slightly alkaline reaction (pH 7.8). While the amount of phosphorus (26.34 mg/kg

P₂O₅) was high, it was sufficient for the amount of potassium (295.53 mg/kg K₂O). There was no salinity (0.8493 dS m⁻¹) problem in the field of experiment fields (Parlak *et al.*, 2008). The research was designed according to the Random Blocks trial design with three replications as plots 20 cm x 5m x 6 rows = 6 m² in size, planting seedlings 3-4 cm deep and planting times for Konya location 01.11.2017 and Gözlü Location 19.10.2017.

Before planting, 3 kg Nitrogen (N) and 8 kg Phosphorus (P₂O₅) were applied in the field. The second dose (3 kg Nitrogen (N) of fertilizer was applied in early spring. The harvest was made on 2-5 July 2018.

NDVI values were obtained by a green scanner on two periods including end of tillering (Z-30; NDVI1) and end of stem elongation (Z-39; NDVI2); sensor readings were made with Green-Seeker Hand Held Optical Sensor Unit (NTech Industries, Inc; 740 South State Ukiah, CA 954852).

NDVI1 readings recorded at Konya-Location on 17.02.2018, Gözlü Location on 18.02.2018, and NDVI2 readings between the dates of 13.03.2018 and 14.03.2018, respectively, each parcel was made from the height of 80-100 cm during 11.00-15:00 hours by keeping the sensor in an upright position (Casedosus *et al.*, 2007).

The normalized difference vegetation index (Normalized Difference Vegetation Index) is used to increase the contrast between near infrared (NIR) and visible red (RED) bands or to collect information from the two bands into a single band and to examine the plant presence at field conditions, It is formulated as $NDVI = (NIR780 - RED670) / (NIR780 + RED670)$ (Rouse *et al.*, 1973).

NIR: Near infrared ray (NIR wavelength of light reflected through the plant after being sent by the sensor)

RED: The red ray (red wavelength of light reflected through the plant after being sent to the plant by the sensor).

The results obtained from the study were subjected to the analysis of variance according to the Random Blocks trial design. The mean values of the applications whose differences were determined by F test were grouped according to the LSD significance test.

RESULTS AND DISCUSSION

The degree of relationship between the normalized difference vegetation index (NDVI) and yield from the physiological parameters, the mean values of the characteristics discussed, and the LSD test groups are presented in Table 1.

The difference between genotypes and locations in terms of normalized difference vegetation index (NDVI₁) during the tillering period (Z-30) was found statistically significant at $p < 0.01$ level, and the mean NDVI₁ value of genotypes was 0.46. The highest value of NDVI₁ was determined in TBVD-18 (0.56) and the lowest value in TBVD-11 (0.39) genotypes; however, the highest value among the varieties was determined in Özer variety (0.48) (Table 1).

The normalized difference vegetation index (NDVI₂) at the end of stem elongation (Z-39) in triticale showed no significant difference genotypes but significant ($p < 0.01$) levels were determined between the locations and the mean of NDVI₂ for genotypes as 0.66 (Table 1).

NDVI is basically the ratio of radiation reflected from healthy vegetation to radiation reflected from all other sources. High NDVI values indicate healthy plant development.

Kizilgeci *et al.* (2017) determined the statistically different ($P < 0.05$) NDVI values of triticale lines between the locations which ranged 0.777-0.813 for Diyarbakir location and 0.722-0.772 for Mardin location. They determined that the mean NDVI values were 0.80 for the Diyarbakir location and 0.75 for the Mardin location.

When genotypes average was examined, NDVI values were similar among genotypes. The different NDVI averages in two different periods can be explained periodically by the multiplicity or absence of green biomass.

Table 1. Mean values of grain yield and NDVI₁, NDVI₂ with “LSD” test groups.

GENOTYP	Yield (kg/ha)	NDVI ₁	NDVI ₂
TBVD-1	3.288 cg	0.46 bh	<u>0.70 ab</u>
TBVD-2	2.965 eh	0.49 ae	0.67 ab
TBVD-3	3.019 eh	0.48 ae	<u>0.71 a</u>
TBVD-4	<u>4.021 ab</u>	0.47 bh	0.69 ab
TBVD-5	3.114 bg	0.43 dh	0.68 ab
TBVD-6	3.136 cg	0.46 bh	0.64 ab
TBVD-7	3.802 ad	0.45 bh	0.68 ab
TBVD-8	2.614 eg	0.40 fh	<u>0.71 a</u>
TBVD-9	2.394 gh	0.39 h	0.65 ab
TBVD-10	3.385 bf	0.41 eh	0.68 ab
TBVD-11	2.764 fh	0.40 gh	0.68 ab
TBVD-12	3.451 ae	0.48 af	0.68 ab
TBVD-13	3.451 bf	0.48 ag	0.60 b
TBVD-14	2.784 fh	0.47 bh	0.70 ab
TBVD-15	3.141 cg	<u>0.56 a</u>	0.70 ab
TBVD-16	<u>4.268 a</u>	<u>0.53 ab</u>	0.62 ab
TBVD-17	2.960 eh	0.47 ah	0.63 ab
TBVD-18	3.510 be	0.47 bh	0.62 ab
TBVD-19	3.502 ae	0.47 bh	0.60 b
TBVD-20	3.652 ad	0.52 ac	0.67 ab
TBVD-21	3.832 ac	0.51 ad	0.67 ab
TBVD-22	3.514 be	0.48 ag	0.64 ab
TATLİCAK-97	<u>3.344 bf</u>	0.42 dh	<u>0.67 ab</u>
ALPERBEY	2.619 gh	0.44 ch	0.66 ab
ÖZER	2.403 h	<u>0.48 ae</u>	0.66 ab
ORTALAMA	322.80	0.46	0.66
LSD	70.34	0.0094	0.053
CV(%)	19	16	13

The difference between genotypes and locations was statistically significant at $p < 0.01$ level for grain yield. The highest grain yield was determined in TBVD-19 (4.267 kg ha⁻¹)

and the lowest was determined in TBVD-11 (2.394 kg ha⁻¹) genotypes with an average of 3.228 kg ha⁻¹. It was determined that Tatlıcak-97 variety had the highest grain yield (3.344 kg ha⁻¹) in standard varieties (Table 1).

The correlation between NDVI values and seed yield was statistically significant ($P < 0.01$) in both periods ($r = 0.59^{**}$, 0.46^{**}). NDVI is thought to measure the combined effect of various growth factors on growth. Therefore, the high NDVI of a genotype indicates that the plant is healthy. Karaman *et al.* (2014) showed that there was a positive and significant correlation between grain yield and NDVI values in bread wheat in insemination period and Kizilgeci *et al.* (2016) reported that there was a positive and significant relationship between NDVI and hectoliter measured in the barley during the period of spike and one thousand grain weight with SPAD and it is similar with the results obtained in our study.

The correlation coefficients between the NDVI values of both periods and seed yield were 0.46^{**} and 0.59^{**} , respectively, and the regression analysis showed that these relations were linear, and the order of NDVI₁ and NDVI₂ was $R^2 = 0.21^{**}$ and $R^2 = 0.35^{**}$ (Fig. 1).

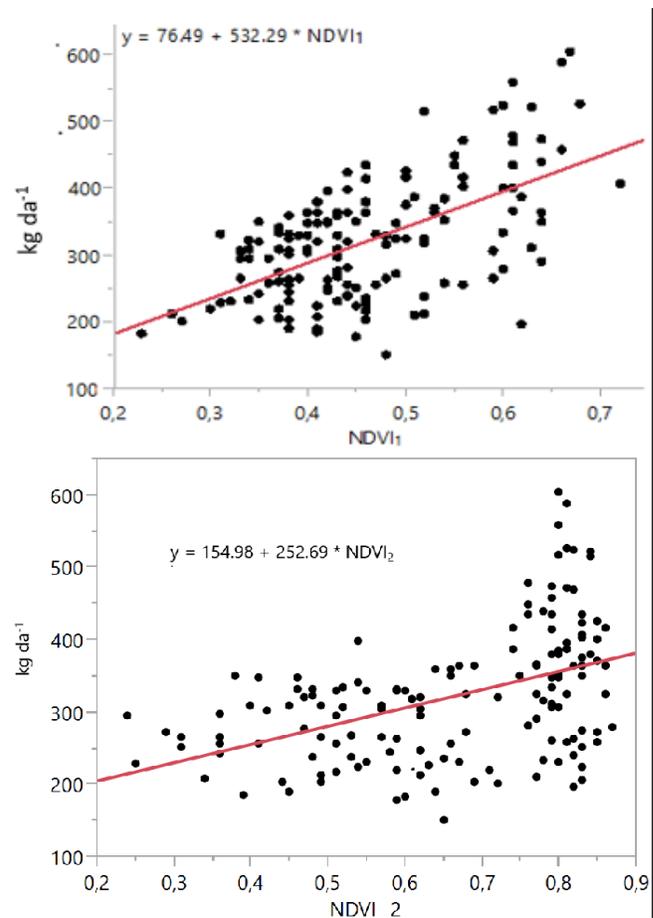


Figure 1. Linear relations between grain yield and NDVI values.

Sonmez and Sari (2002) reported that there was a linear relationship between the reflections of the plant canopy and a complex structure consisting of mosaic of many leaves, other plant structures, soil structure and shadow. Considering that the relationship between a healthy canopy and yield potential is positive.

Conclusion: NDVI measurements, which are most commonly used in remote sensing methods, can be used to generate yield prediction models. In general, the yield estimation models consist of a combination of remote sensing data. The use of NDVI measurements in triticale breeding at different periods enables the estimation of grain yield and the idea that the plant is in healthy development.

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