SPECTRAL CHARACTERISTICS OF WHEAT AS INFLUENCED BY NITROGEN STRESS

Dr. Vyas Pandey, Deepti Verma, B.I. Karende, M.M. Lunagaria, K.I. Patel
Professor and Head
Dept. of Agril. Meteorology
B.A.C.A, AAU, Anand

- **Wheat *(Triticum aestivum L.)* is the most important crop of India grown both in rain fed and in irrigated regions.**

- **The biotic and abiotic factors affect the growth, development and yield.**

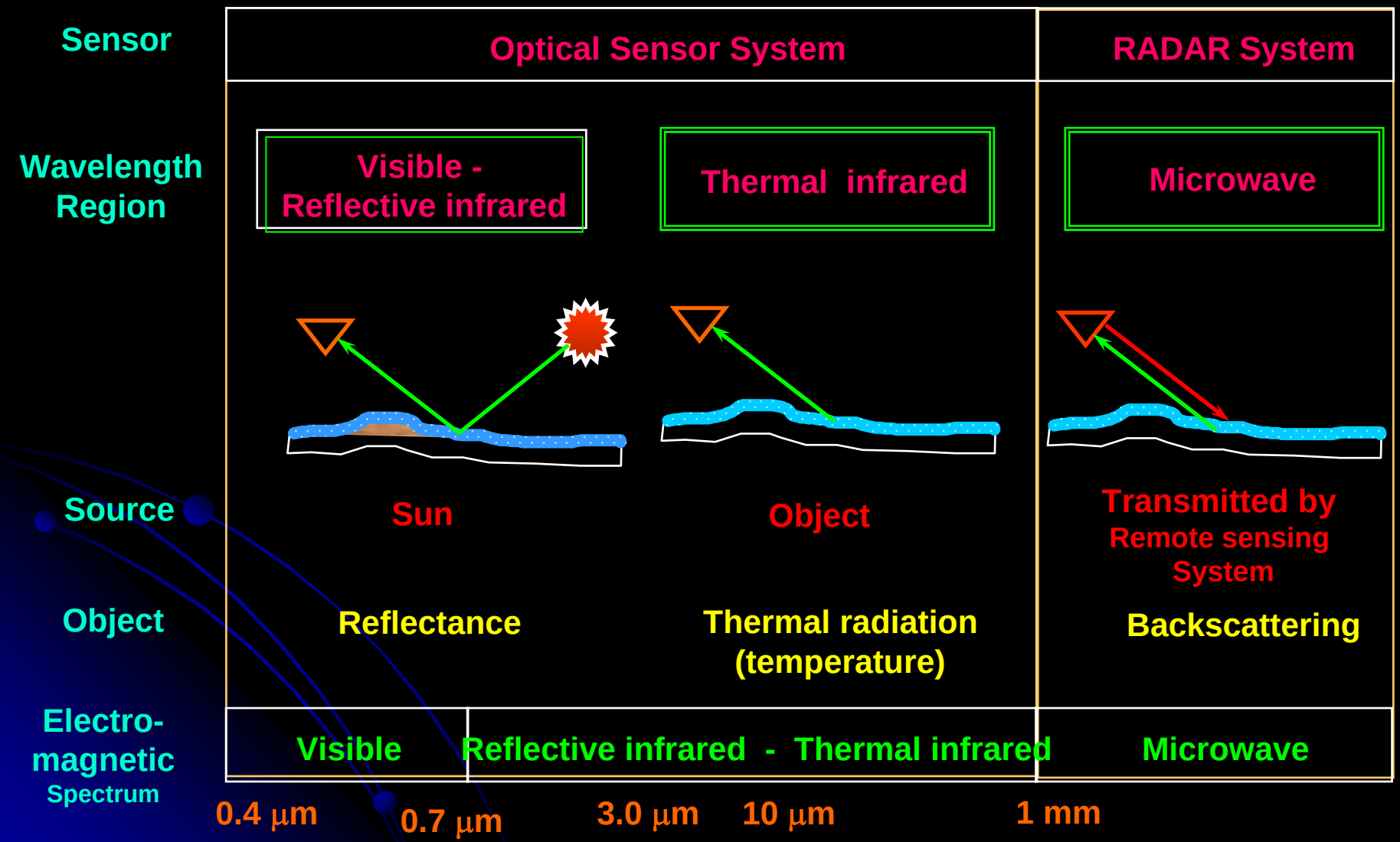
- **The moisture and nitrogen stress at different stages of the wheat are the major cause of lower productivity.**

- **Remote sensing technique offers a unique solution for mapping stress and monitoring, its time course. Remote sensed observations are used in quantifying stress level and to mitigate its impact on crop production.**

What is Remote Sensing..???

- Remote sensing refers to the science of identification of earth surface features and estimation of their geo-physical properties using electro-magnetic radiation.
- OR, Remote sensing is the science of acquiring information about the earth's surface without actually being in contact with it. This is done by sensing and recording reflected or emitted energy and processing, analyzing and applying that information.

Remote Sensing Systems



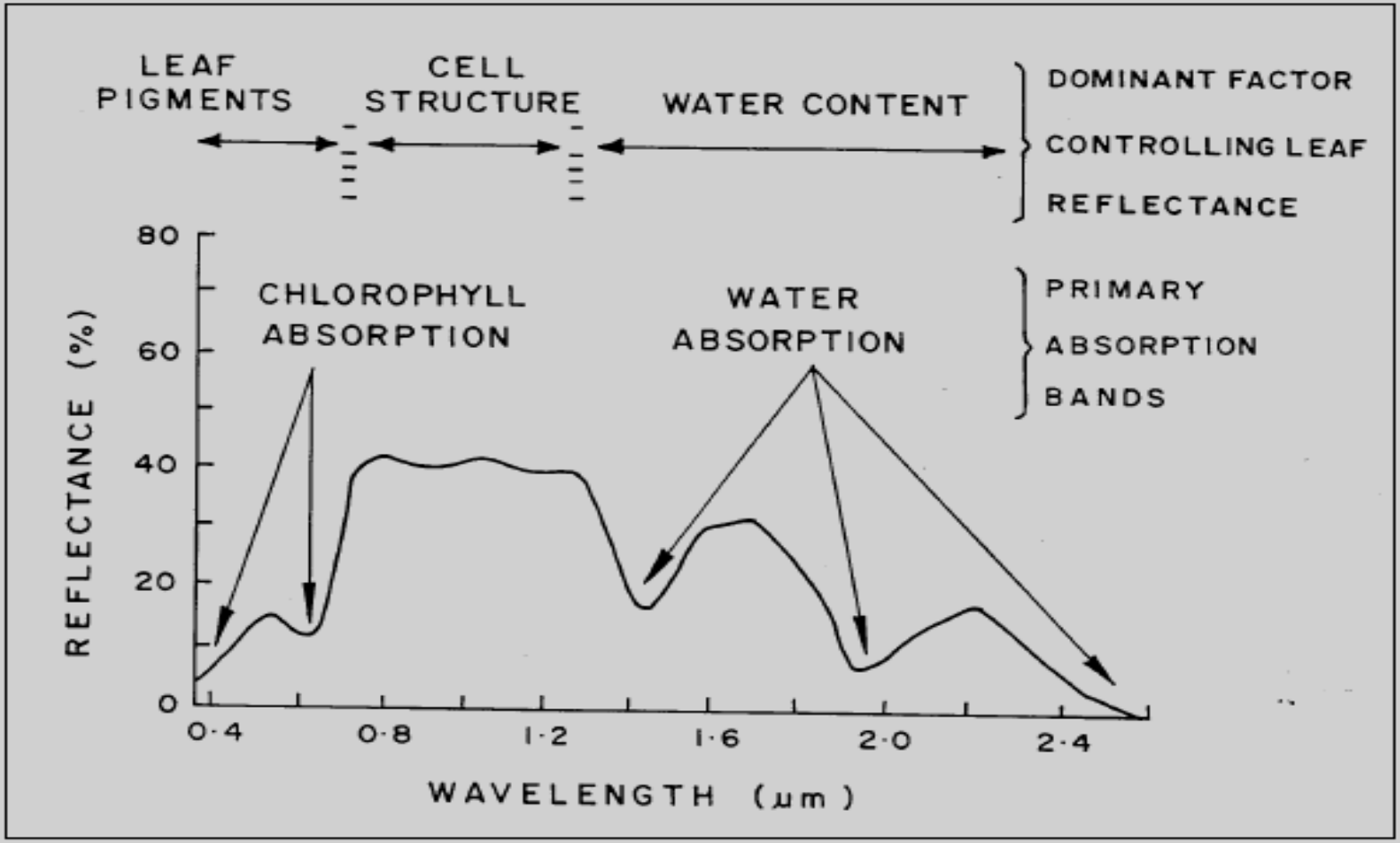


Fig.1, Typical vegetation spectral curve with corresponding color reflected by at each wavelength

Experimental Site:	**College Agronomy Farm, AAU, Anand (Gujarat)**
Design:	**Split plot design**
Replication:	**Four (4)**
Main Plot Treatment:	**Varieties (Two)** **V-1- GW-496** **V-2- LOK1**
Sub Plot Treatment:	**Fertilizer levels (Five) (kg/ha)** **N-1: 120+60+00 NPK** **N-2: 90+60+00 NPK** **N-3: 60+60+00 NPK** **N-4: 30+60+00 NPK** **N-5: 00+60+00 NPK**
Treatment Combinations:	**Ten**
Plot size:	**Gross 5.00x2.70 sq. m** **Net 4.00x1.80 sq. m**
Spacing:	**22.5cm between rows**

Spectral observations

- **Spectral observations at canopy level were taken at 10 days interval starting at 25 days after sowing (DAS) by using Unispec-DC version 2.02.**

- **Spectroradiometer operating in wavelength of 310-1100 nm covering visible and near infrared portion of the spectrum.**

- **Data were taken between 10:30-11:30 AM on cloud free day from all plots under different treatments.**

- **Observations were taken at different growth stages of wheat like, tillering, jointing, booting, heading, flowering, milking, dough, maturity.**

- **Spectral data were used to derive the different vegetation indices.**

- **The reflectance was calculated as the ratio between the reflected and incident spectra of the canopy.**

VEGETATIVE INDICES

To use the information contained in the reflectance across wavelengths, several VI have been proposed. VI is the quantative measure used to measure biomass or vegetative vigor. These indices are primarily based on
ratio or difference between the reflectance in various wavelengths.

Each index provides a description of the canopy response during period of particular growth stage under the study.

Ratio vegetation index

- Ratio vegetation index was first described by Jordan(1969).
- This is the simplest among the ratio based VI, which has the ratio of NIR to RED (Reflectance). i.e.,

RVI = NIR / RED

- Range of RVI is from zero to infinity.
- If both the RED and NIR bands have the same or similar reflectance, then the RVI is 1 or close to 1. RVI values for bare soils generally are near 1; as the amount of green vegetation increases the RVI increases.

NORMALIZED DIFFERENCE VEGETATION INDEX

- NDVI is the normalized difference vegetation index which is ascribed to *Rouse et. al.* (1973), but the concept of a normalized difference index was first presented by *Kriegler et al.* (1969).
- NDVI is the most widely used technique to understand the vegetation health status, it is calculated from the visible red and near infrared light reflected by vegetation i.e.,

$$NDVI = (NIR - red) / (NIR + red)$$

- The range of NDVI is from -1 to 1.
- Vegetated areas will typically have values greater than zero and negative values for non-vegetated surface features such as water, barren land, ice, snow or clouds.

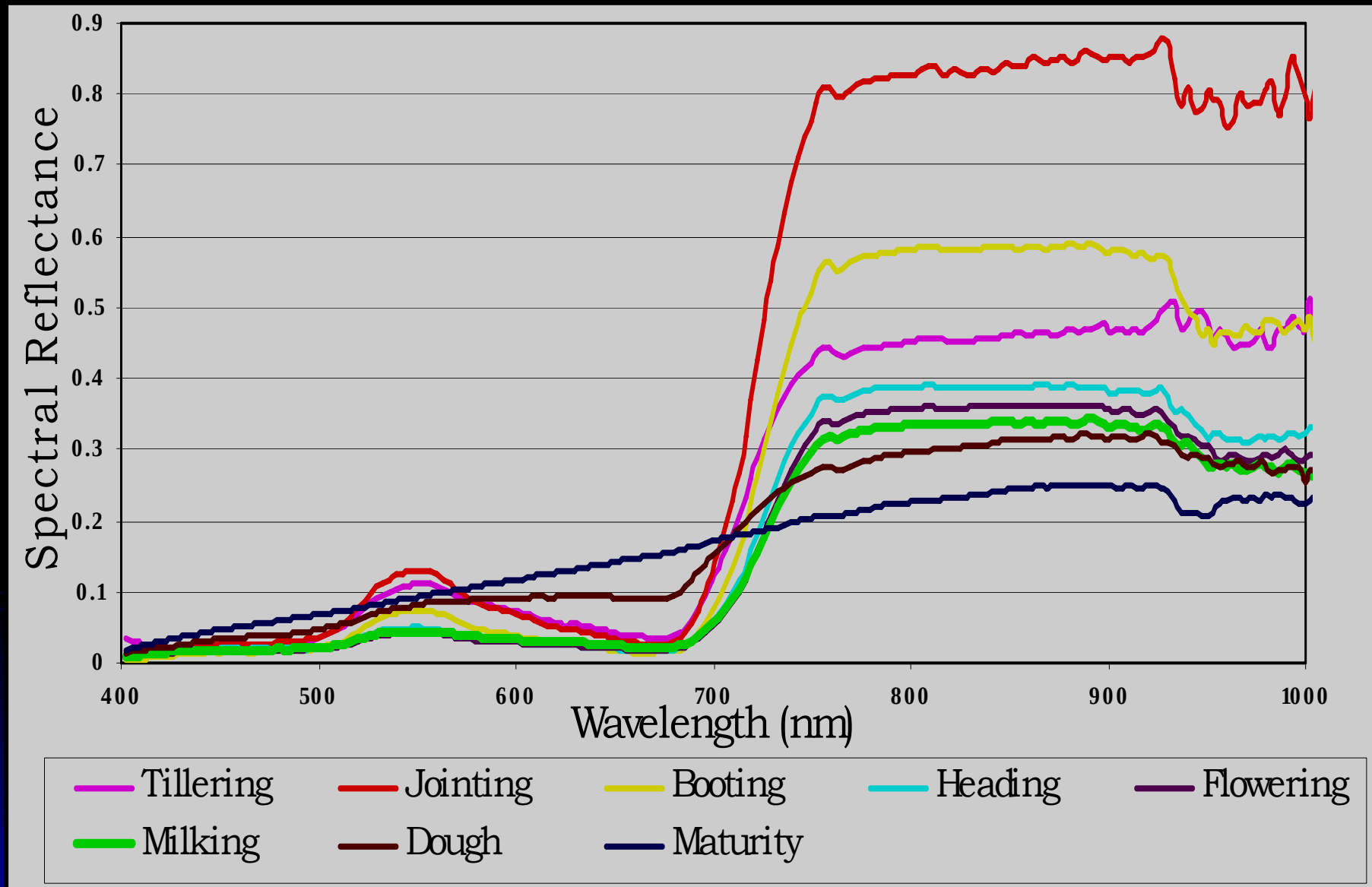


Fig.2. Spectral reflectance of wheat at different phenological stages

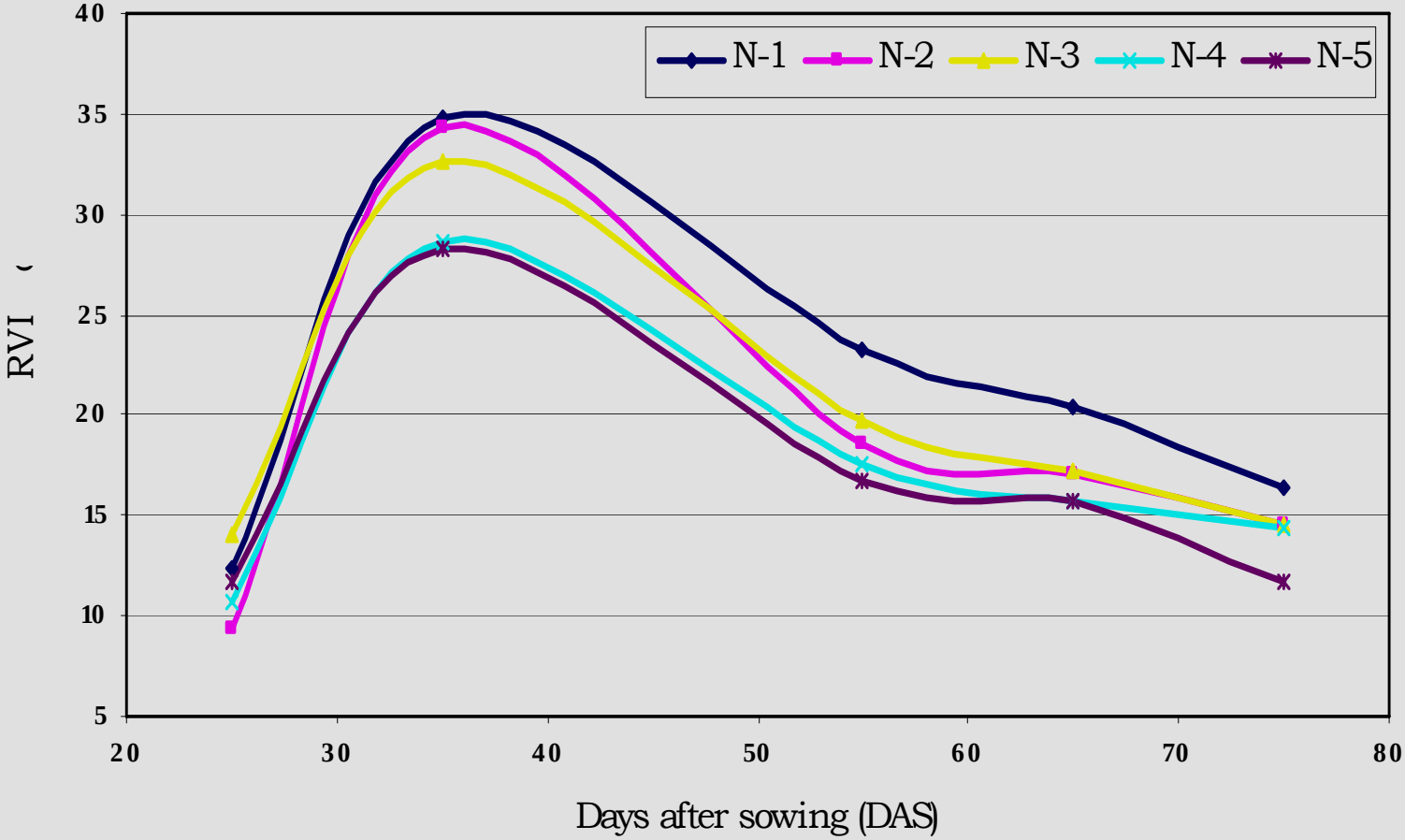


Fig.3. Effect of nitrogen level on Ratio Vegetation Index

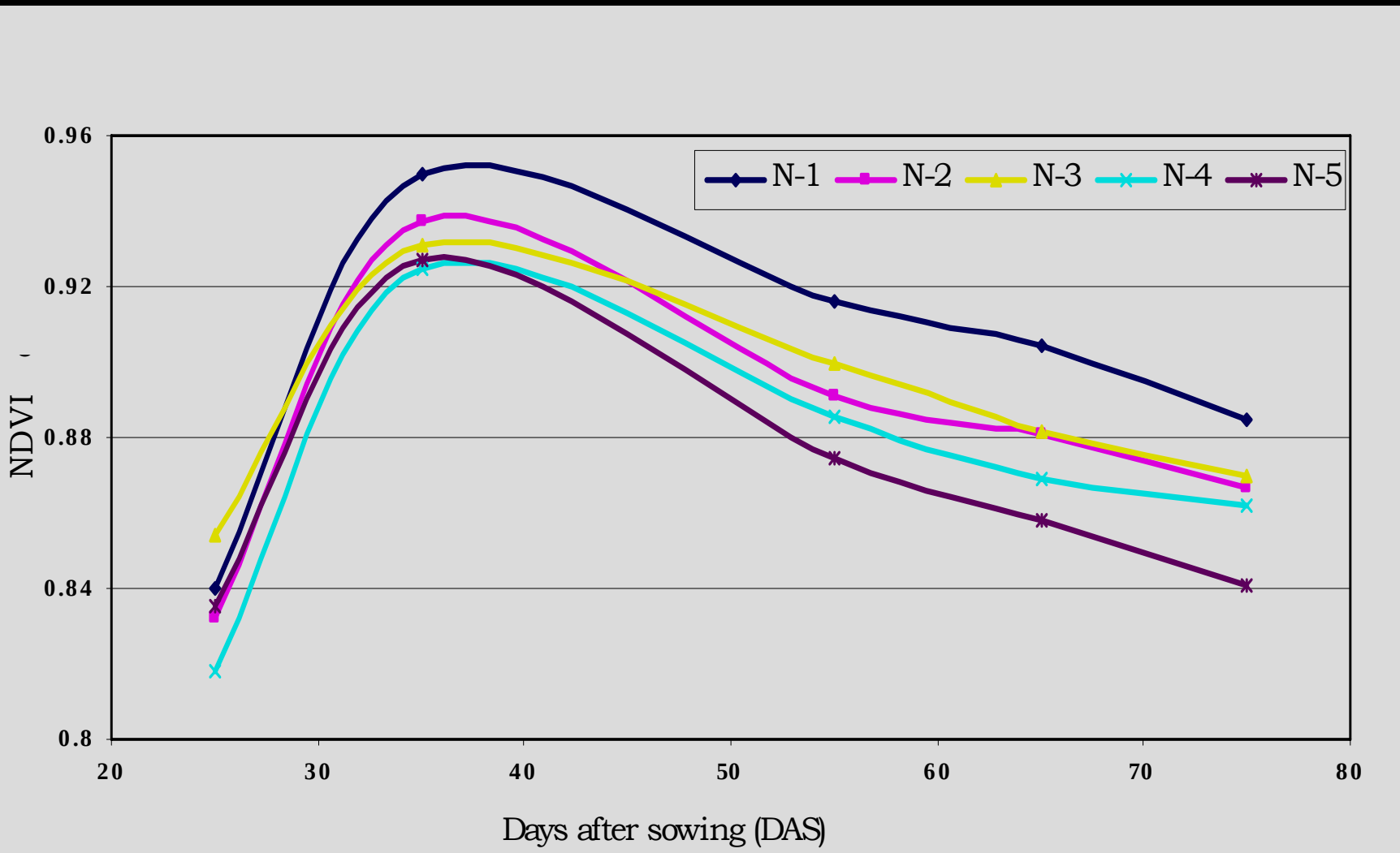


Fig.4. Effect of nitrogen level on Normalized Difference Vegetation Index

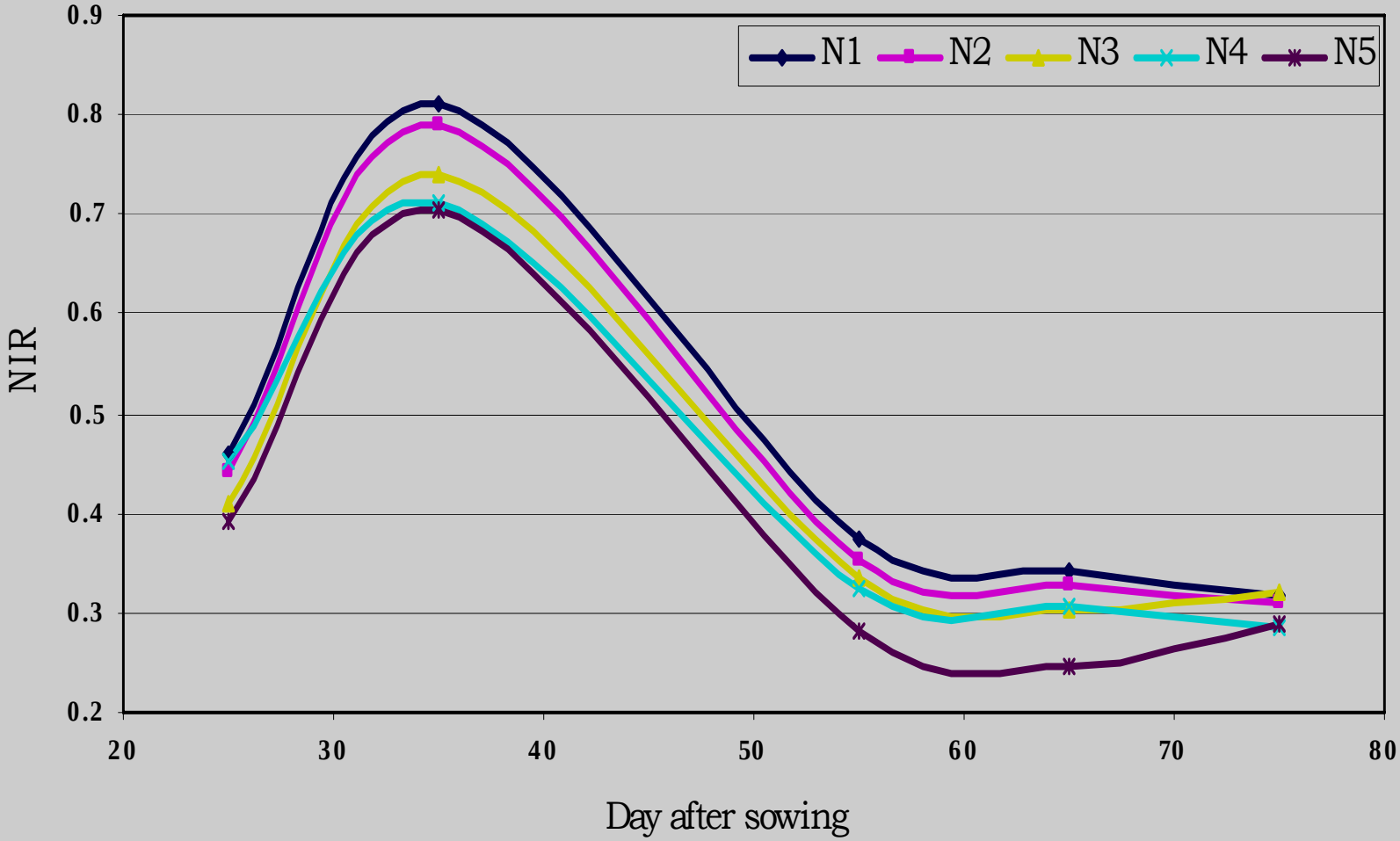


Fig.5. Effect of nitrogen level on NIR reflectance

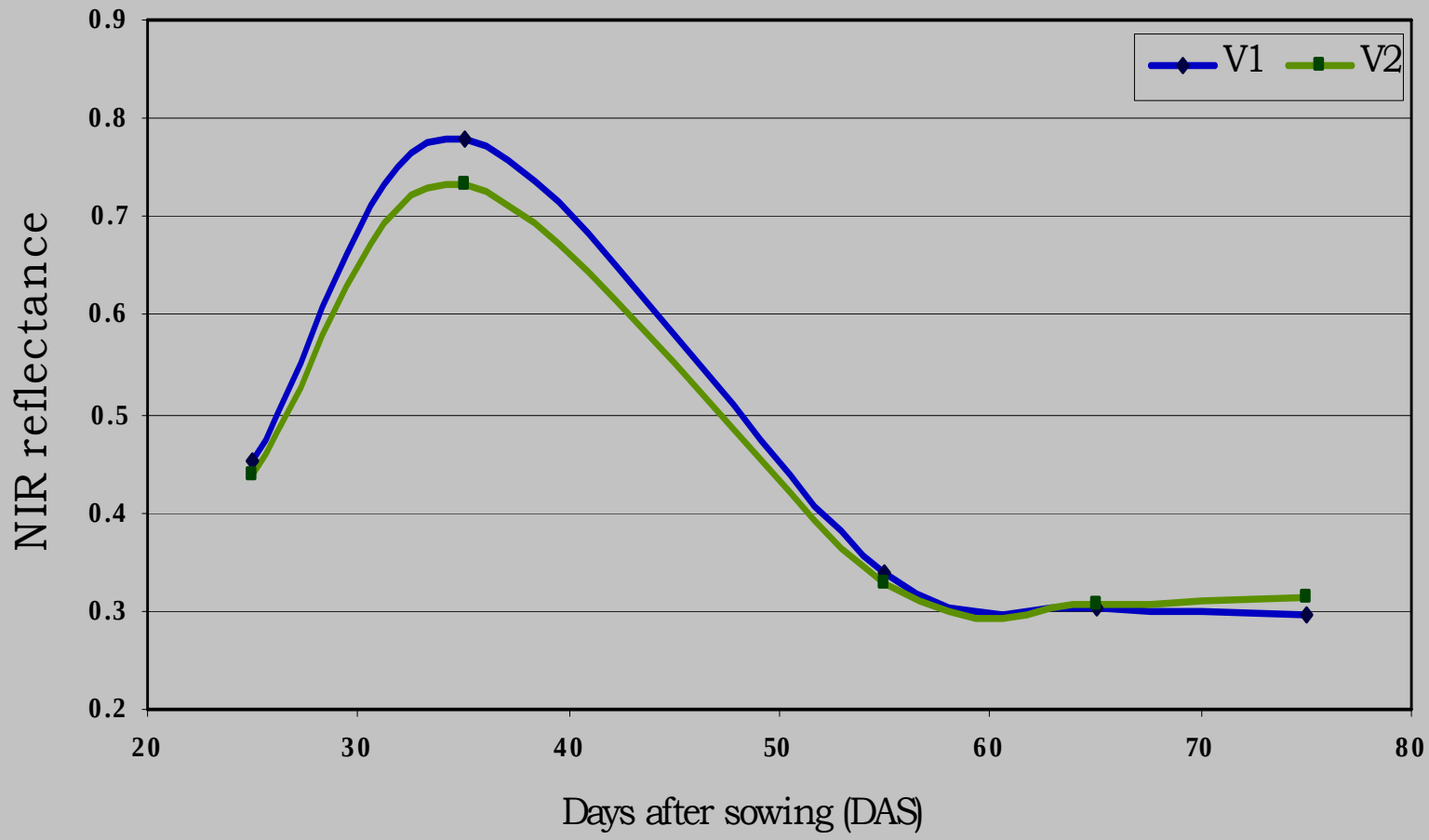


Fig.6. Effect of varieties on NIR reflectance

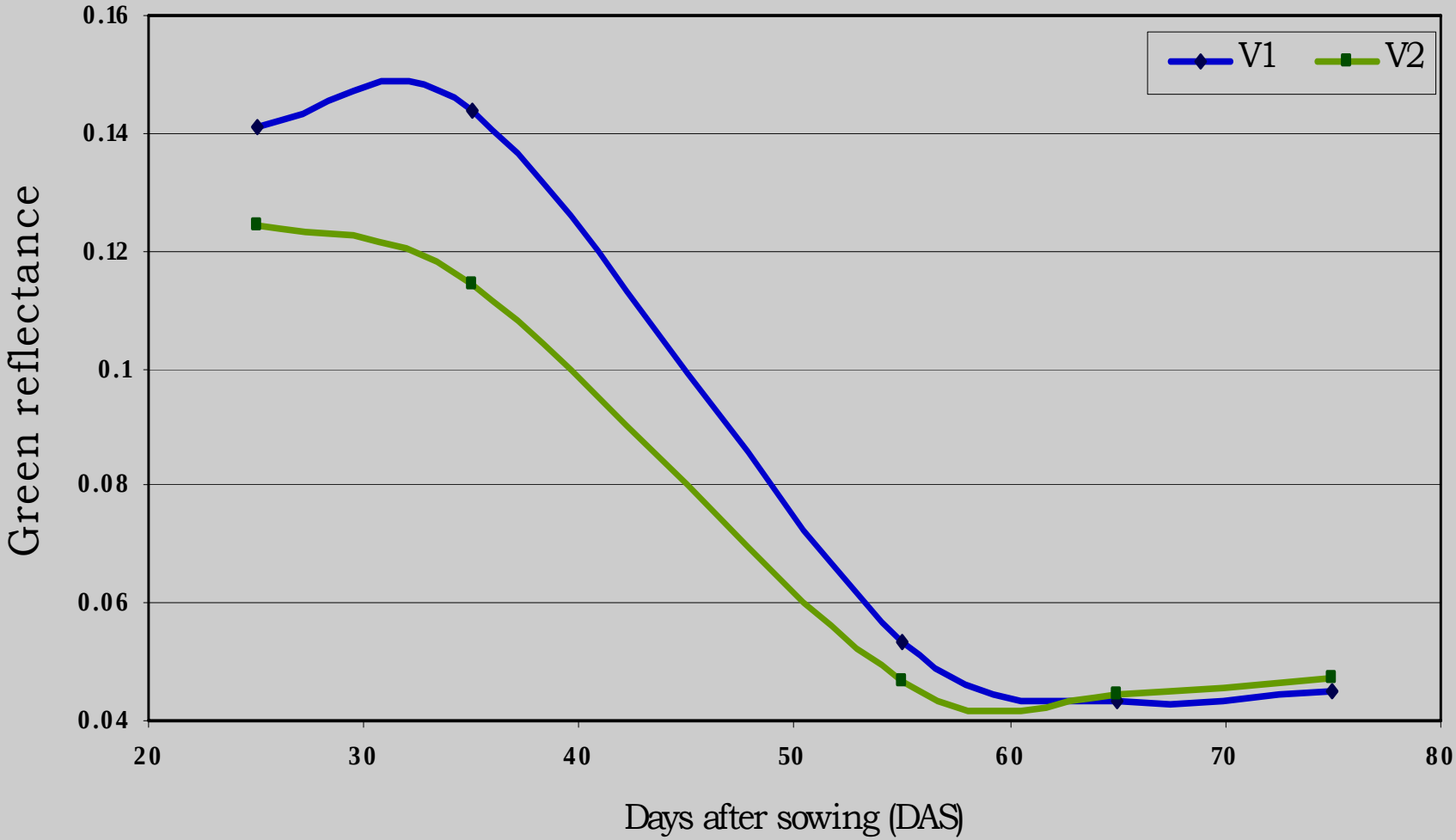


Fig.7. Effect of varieties on green reflectance

Stages	Biomass	LAI	Grain yield
Tillering	0.271	0.145	0.269
Jointing	0.660*	0.803**	0.896**
Heading	0.678*	0.741*	0.725*
Flowering	0.825**	0.671*	0.453
Milking	0.856**	0.821*	0.543

* denotes significant at p= 0.05
** denotes significant at p= 0.01

Table.1. Correlation coefficient between RVI at different stages and biomass, LAI and grain yield

Stages	Biomass	LAI	Grain yield
Tillering	0.119	-.067	0.121
Jointing	0.419	0.771**	0.690*
Heading	0.636*	0.707*	0.770**
Flowering	0.778**	0.556	0.540
Milking	0.887**	0.852	0.636*

* denotes significant at p= 0.05
** denotes significant at p= 0.01

Table.2. Correlation coefficient between NDVI at different stages and biomass, LAI and grain yield.

Stages	Biomass	LAI	Grain yield
Tillering	0.162	0.013	0.206
Jointing	0.561	0.691*	0.728*
Heading	0.828*	0.789**	0.734*
Flowering	0.861**	0.643*	0.598
Milking	0.887**	0.813**	0.575

* denotes significant at p= 0.05, ** denotes significant at p= 0.01

Table.3. Correlation coefficient between NDRE at different stages and biomass, LAI and grain yield

Stages	Biomass	LAI	Grain yield
Tillering	0.139	-.041	0.150
Jointing	0.417	0.750*	0.707*
Heading	0.858**	0.943**	0.776**
Flowering	0.834**	0.930**	0.471
Milking	0.961**	0.839**	0.656*

* denotes significant at p= 0.05, ** denotes significant at p= 0.01

Table 4. Correlation coefficient between GNDVI at different stages and biomass, LAI and grain yield

Stages	Biomass	LAI	Grain yield
Tillering	0.231	0.067	0.274
Jointing	0.473	0.743**	0.739*
Heading	0.908**	0.893**	0.732*
Flowering	0.876**	0.924**	0.431
Milking	0.897**	0.803**	0.550

* denotes significant at p= 0.05, ** denotes significant at p= 0.01

Table.5. Correlation coefficient between NRI at different stages and biomass, LAI and grain yield

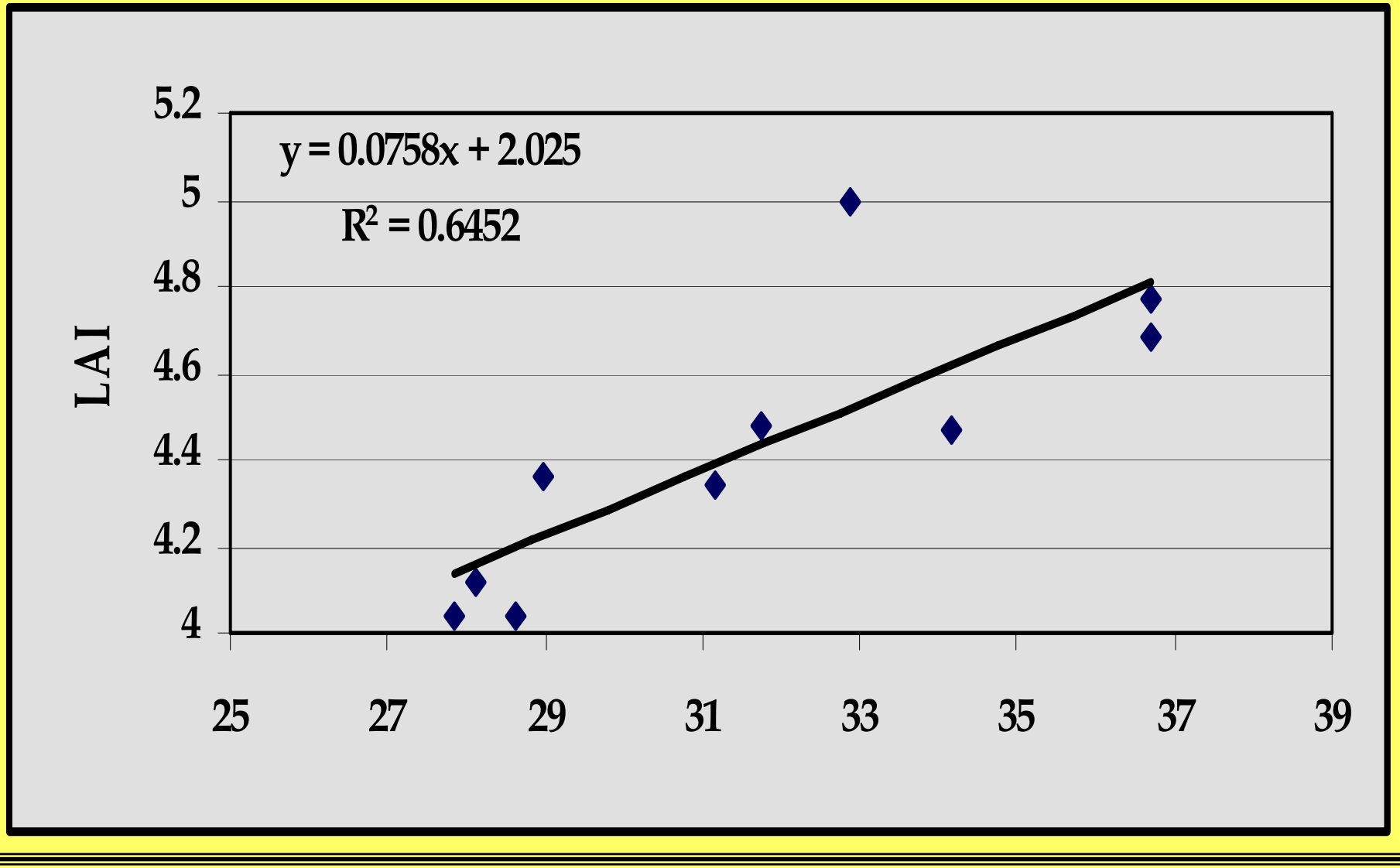


Fig.8. Relationship for predicting LAI using RVI and at jointing stage

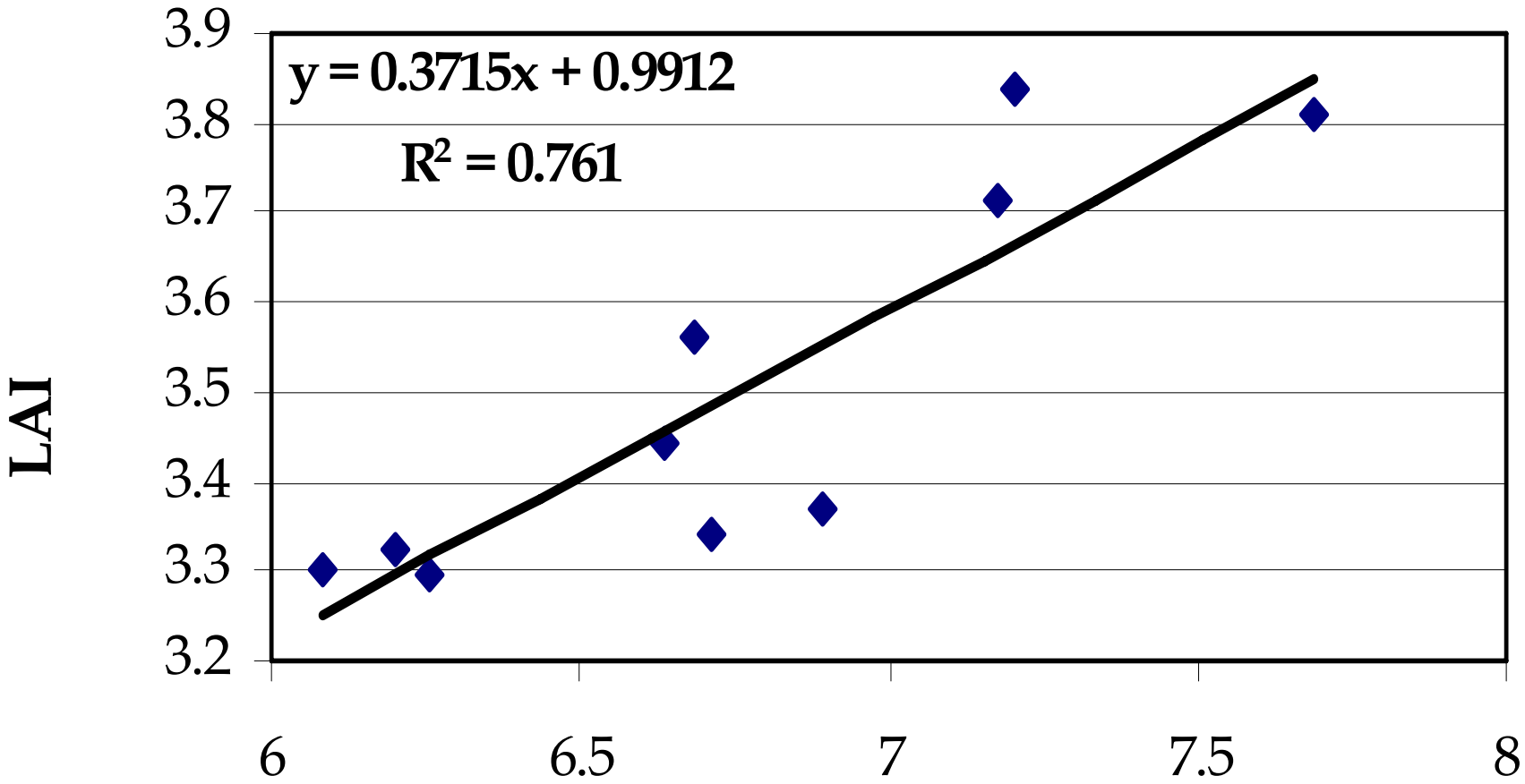


Fig.9. Relationship for predicting LAI using NRI and at heading stage

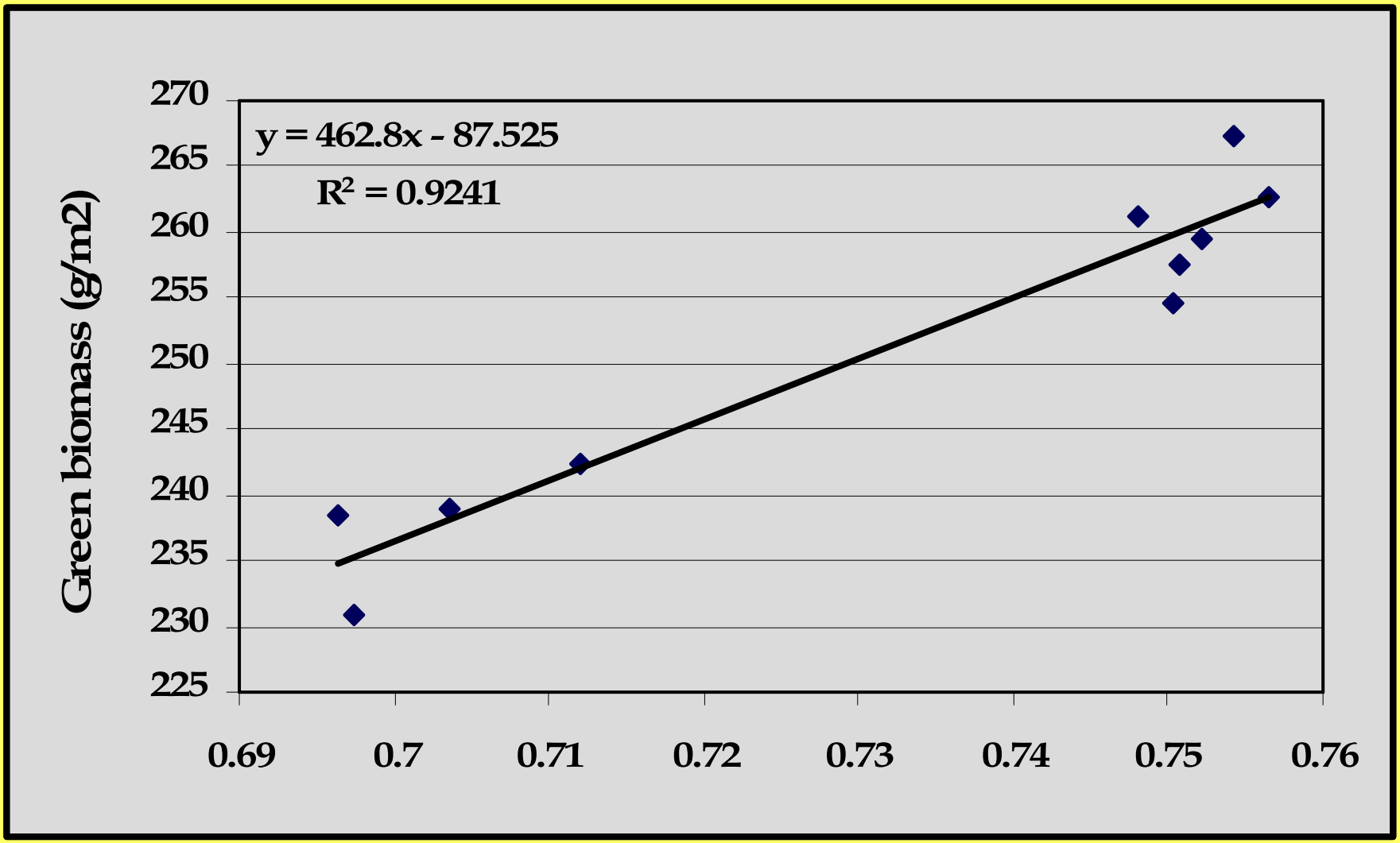


Fig.10. Relationship for predicting biomass using GNDVI at milking stage

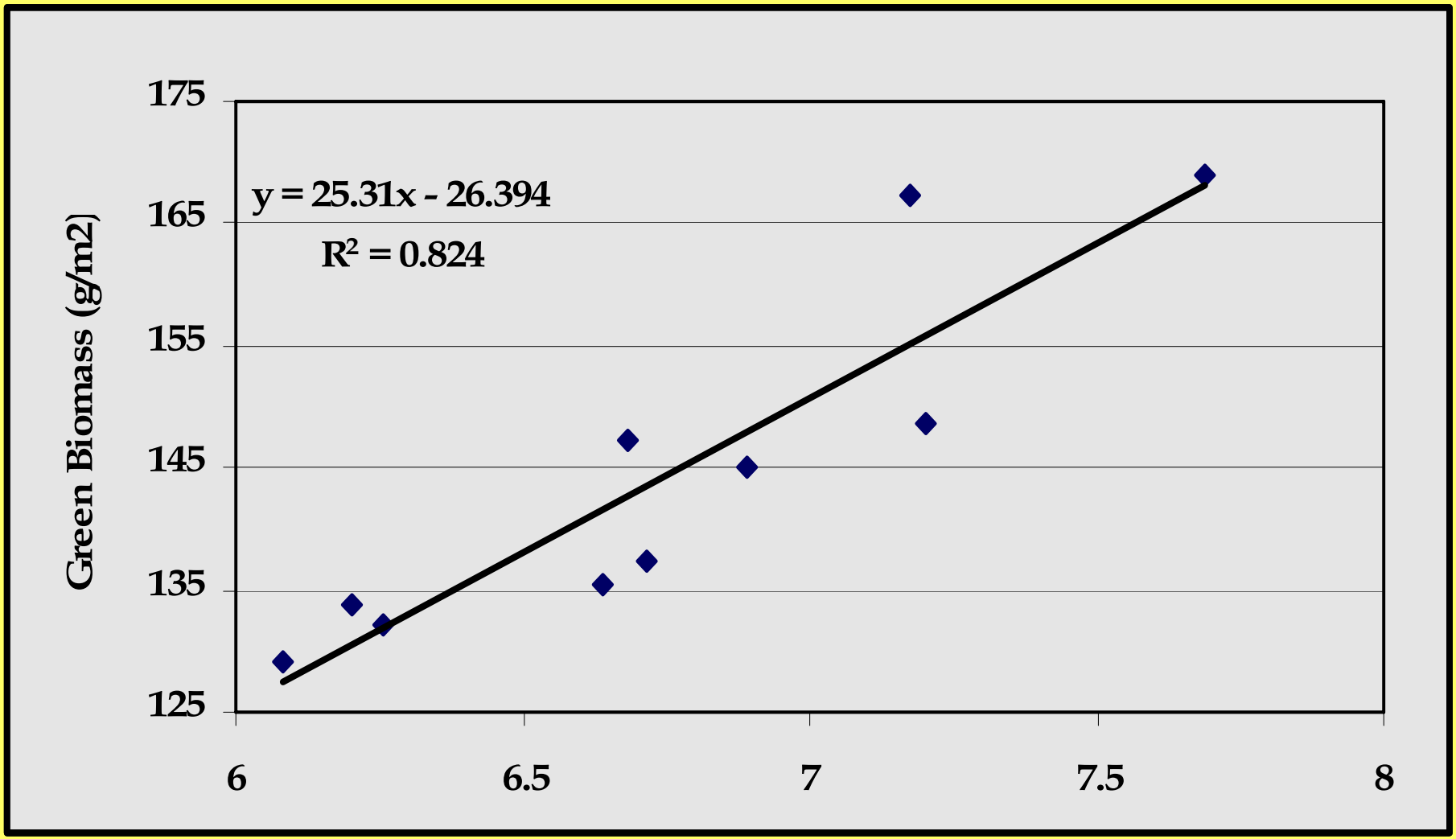


Fig.11. Relationship for predicting biomass using NRI at heading stage

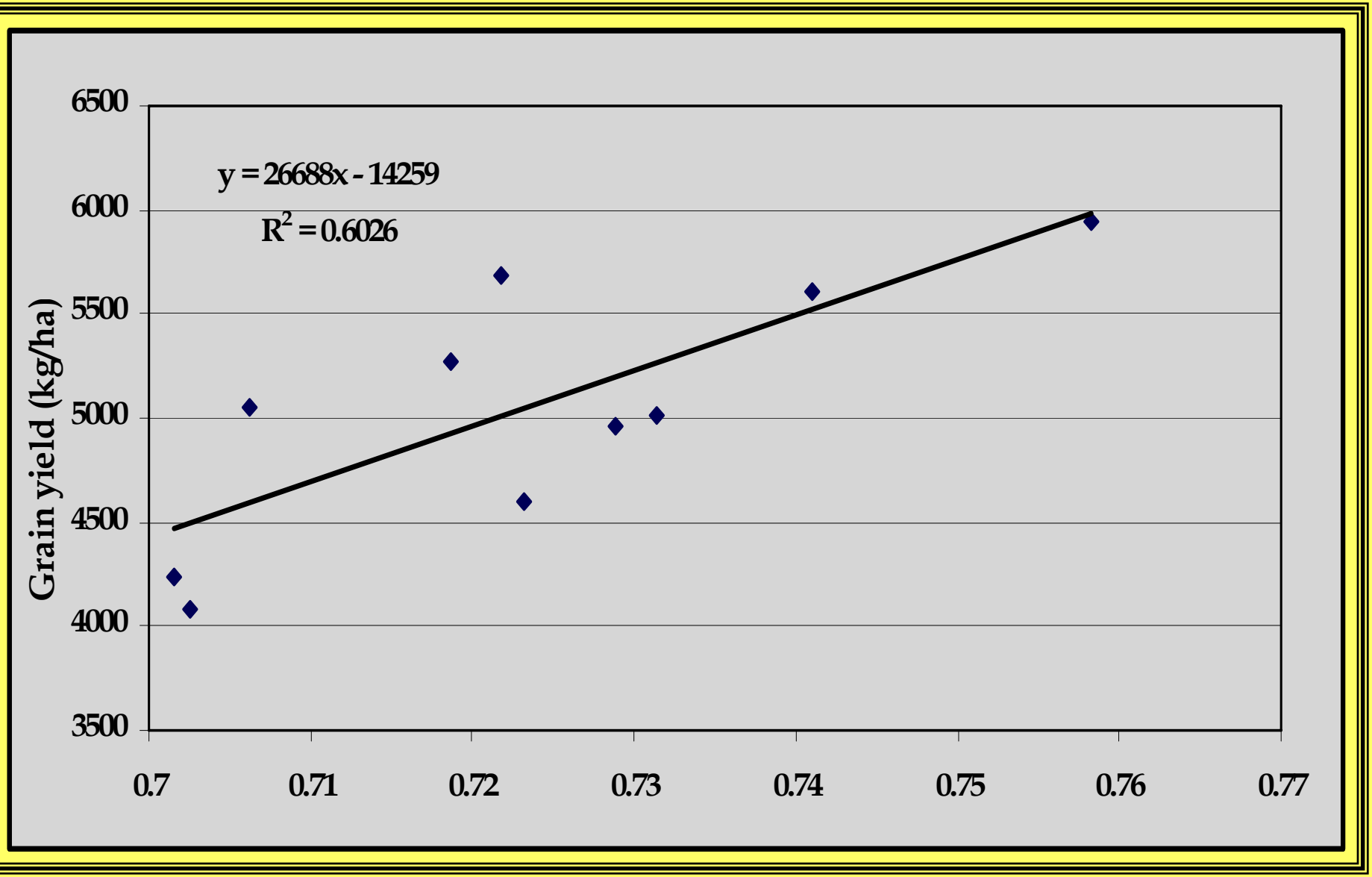


Fig.12. Relationship for predicting grain yield using GNDVI at heading stage

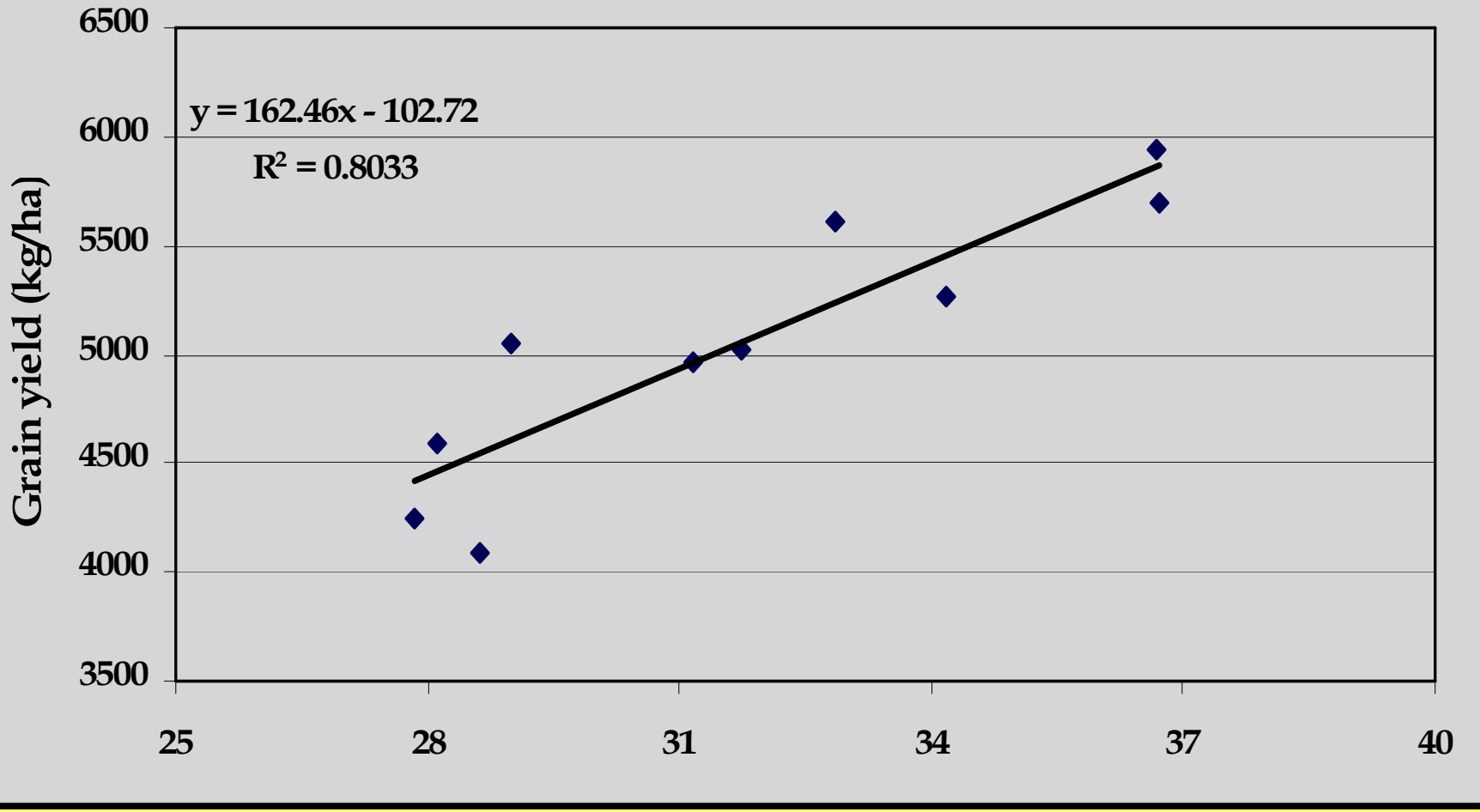


Fig.13. Relationship for predicting grain yield using RVI at jointing stage

Conclusion

- Spectral reflectance characteristics of wheat was found to be influenced by variety and nitrogen stress.
- The spectral signatures are helpful in identifying the stage of the crop.
- Variety LOK1 and GW-496 can be discriminated using spectral reflectance in NIR.
- Nitrogen stress can also be identified using spectral indices at jointing stage.
- Biomass was significantly correlated with spectral at jointing, heading, flowering and milking stage of wheat.
- LAI was also significantly correlated with RVI, NDVI, NDRE, GNDVI and NRI
- The grain yield was significantly correlated with spectral indices at jointing, heading and milking stage.
- Regression developed with spectral indices can be used to predict the biomass, LAI and grain yield of wheat.


Thank you